CHAPTER 3: AFFECTED ENVIRONMENT[1]

3.1 Introduction

The purpose of this chapter is to describe the environment of the area(s) to be affected or created by the alternatives under consideration (40 C.F.R. §1502.15). This chapter provides the context in which the impacts described in Chapter 6, Environmental Consequences, would occur. The description of the affected environment includes areas that may be affected by presently proposed and future Early Restoration actions.[2] Although the OPA NRDA regulations do not constrain the geographic location of restoration projects, the affected environment for purposes of this Early Restoration Programmatic Environmental Impact Statement (PEIS) is the northern Gulf of Mexico region[3]. This area is comprised of complex biological communities of interacting organisms, including humans, and their physical environment(s).

As described in Chapter 4, the Trustees are in the process of assessing injuries caused by the Spill to natural resources and the services provided by these resources. The spatial scope of the assessment includes the northern Gulf of Mexico region. The Assessment work to date clearly demonstrates areas of extensive oiling of marsh and beach shorelines from Texas to the Florida Panhandle. Preliminary results also make clear that the oiling has had significant adverse impacts on coastal and nearshore habitats and their biological communities. In addition, initial results from the Trustees' Assessment clearly show that oiling caused very large reductions in coastal recreation from Texas to Florida. The full extent and duration of impacts on the Gulf of Mexico resources and habitats are still being evaluated; thus, impacts from the Spill are not presented in Chapter 3 in the description of the affected environment. Chapter 4 provides an update on the injury assessment as context for the Early Restoration. The Trustees consider injuries caused by the Spill to be part of the affected environment for purposes of this Early Restoration PEIS.

The affected environment is discussed in more detail in each of the following subsections:

Section 3.2 Physical Environment: The Gulf of Mexico is a large basin. Its greatest east-west and north-south extents are approximately 1,100 and 800 miles, respectively, with a surface area of approximately 600,000 square miles, and containing approximately 584,000 cubic miles of water. The basin is bordered by Cuba, Mexico, and the United States (U.S.), and consists of an intertidal zone, continental shelf, continental slope, and abyssal plain. The U.S. portion of the Gulf extends from the southern tip of Texas eastward to the Florida Keys, following the coastline of five states: Texas, Louisiana, Mississippi, Alabama, and Florida. This northern portion of the Gulf of Mexico is dominated by inputs from the

[1] Portions of this section were drawn from multiple sources many of which were also used for description of the affected environment for the *Final Programmatic Environmental Assessment for the Initial Comprehensive Plan: Restoring the Gulf Coast's Ecosystem and Economy* (http://www.restorethegulf.gov/sites/default/files/Final%20PEA%20Aug%206.pdf).

[2] If future early restoration projects are proposed with the potential for effects outside of the northern Gulf of Mexico region, additional detail on the affected environment would be provided in the appropriate NEPA documentation analyzing the proposed projects. If necessary, additional NEPA analysis would meet the requirements of Executive Order 12114.

[3] Note that more specific detail on the affected environment is provided for individual, proposed projects in Chapters 8-12.

Mississippi River Basin (MRB), which drains 41% of the contiguous U.S. and contributes 90% of the freshwater entering the Gulf (U.S. EPA 2011). These inflows provide the nutrients and hydrological conditions that make the northern Gulf of Mexico one of the most unique natural areas in the world. The description of the physical environment of the northern Gulf includes information on the geology and substrates, hydrology and water quality, air quality, and noise characteristics of the area.

Section 3.3 Biological Environment: The northern Gulf of Mexico region contains a range of habitats that support diverse and productive ecosystems, with both nursery and feeding grounds for ecologically and economically important species (GCERTF 2011). The biological environment of the northern Gulf of Mexico can be divided into two broad categories: habitats and living coastal and marine resources. The northern Gulf Coast contains a variety of habitats including wetlands (e.g., mudflats, salt pannes, tidal flats, forested wetlands, pine savannas, riparian forests, swamps, and mangroves), barrier islands, beaches and dunes, submerged aquatic vegetation (SAV) beds, and other habitats in the coastal environment. These habitats shelter 97% of all fish and shellfish harvested from the region during spawning, larval development, or other parts of their life cycle (NOAA 2010). In addition, these habitats support thousands of marine and terrestrial species, including more than 15,000 marine species (many of which are globally significant resources), and dozens of threatened or endangered mammals, fish, birds, and reptiles (NOAA 2011a, NOAA 2012, and USFWS 2012b). This high level of diversity in both habitat types and species increases the productivity and stability of the Gulf Coast (Brown et al. 2011).

Section 3.4 Human Uses and Socioeconomics: Millions of people live, work, and recreate in the northern Gulf of Mexico region, and therefore, rely on the natural and physical resources the Gulf's environment provides. In addition to the ecological significance of its natural resources, as well as its range of habitats, the northern Gulf of Mexico ecosystem is also culturally and socioeconomically important to the people of the region and the nation. Coastal areas in the component states contain dozens of culturally important State and National Parks. In addition, the economy of the northern Gulf of Mexico is highly intertwined with its natural resources, which include: oil and gas deposits; commercial and recreational fisheries; waterfowl, migratory birds, and other wetland-dependent wildlife; and coastal beaches and waterways for ports, waterborne commerce, and tourism. In 2009, the total economy of the Gulf of Mexico region supported over 22 million jobs (17.2% of all jobs in the US), and produced over $2 trillion in GDP (16.7% of all GDP produced in the U.S.) (NOAA 2012g).

3.2 Physical Environment

This section provides a description of the geology and substrates, hydrology and water quality, air quality and noise characteristics of the northern Gulf of Mexico, in marine, upland, and transition environments. The nearshore, marine environment is comprised of the coastline and the inner continental shelf (Figure 3-1), extending to depths of 600 feet. The offshore, marine environment consists of portions of the Gulf of Mexico that are more than 600 feet deep including the outer shelf, continental slope, and abyssal plain. Coastal transition areas typically include tidally influenced areas (e.g., marshes, estuaries, and coastal wetlands). Finally, upland environments are those habitats that are adjacent to coastal transition, but are not subject to a tidal regime or regularly inundated by water.

3.2.1 Geology and Substrates

This section describes the geology and substrates of the northern Gulf of Mexico region, including upland geology and soil and nearshore coastal geology and sediment. Sediment resources are particularly important along the northern Gulf Coast areas dominated by deltaic processes (e.g., Mississippi River Delta), and where land building and erosion are dynamic and dependent on the availability of sediment resources.

3.2.1.1 Upland Geology and Soil

The upland coastal area, from southern Texas to the Florida panhandle, has a relatively homogeneous substrate comprised of four distinct bands of sedimentary rock. Florida's peninsular Gulf Coast is less homogeneous, consisting of a wider variety of sedimentary rocks. Soils in the northern Gulf of Mexico region are grouped according to the parent rock, or combination of rocks, upon which they are formed and associated, and are thus called "soil associations". Appendix A.1 presents the various soil associations found throughout the coastal area of the Gulf.

3.2.1.2 Nearshore Coastal Geology and Sediment

Nearshore substrates in the northern Gulf coastal environment tend to be primarily composed of clay, silt, and sand-sized material; silt and clay are most prevalent, but sand is concentrated where present. As such, unconsolidated sand, silt, and clay sediments comprise the primary substrates for habitats in the nearshore Gulf of Mexico.

Sediment sources in the northern Gulf coastal environment are predominately fluvial (associated with rivers and streams), especially west of the Alabama-Florida border. The Mississippi River is the primary source of sediment for the central and western Gulf Coast (including the nearshore environments of Louisiana, Mississippi, and Alabama). Texas has a number of rivers such as Sabine, Neches, Trinity and Brazos that contribute sediments to the nearshore waters and bay systems; however, the majority of its offshore sediment deposits are from the Mississippi/Atchafalaya river basins. Sediment discharge in the Mississippi River has been largely confined within the River's engineered channel banks, which effectively transport sediment material off the continental shelf, removing it from the nearshore coastal system. Mobile Bay, the second largest bay/delta system in the U.S. (ADCNR 2008b), also contributes sediment to the Central Gulf, primarily via the Mobile and Tensaw Rivers, and in Mississippi, both the Pearl and Pascagoula River systems contribute sediment to the Gulf. The sediment of the Florida peninsula nearshore environment differs from the rest of the Gulf Coast nearshore environments because it consists of predominately reworked carbonate that originates from the karst bedrock dominating the region (GOMA 2009). This is not true, however, for the Florida panhandle nearshore environment, which is composed of predominantly quartz sand.

Sediment deposition along the coastal environment is influenced by numerous physical processes including waves, winds (i.e., aeolian processes), river flows, and tidal currents. Nearshore sediment transport processes are particularly influenced by waves and tidal currents, which can cause frequent entrainment and transport of sediments in intertidal, benthic habitats. In addition, bottom currents transport sediments and deposit them differentially based on grain size, shaping the topographic features along the intertidal zone and continental shelf, and affecting the distribution of sediments, their chemical composition, and the availability of habitat to benthic organisms.

Unconsolidated sand, silt and clay sediments provide habitat for benthic organisms in the Gulf of Mexico. Physical processes (e.g., wave action and bottom currents) and chemical processes (e.g., breakdown of organic material and nitrogen cycling) regulate the abundance, type, and distribution of benthic organisms in the Gulf of Mexico (Gihring et al. 2009). The Gulf of Mexico Regional Ecosystem Restoration Strategy (GCERTF 2011) specifically highlighted the importance of sediments to the region, indicating that sediments delivered by Gulf river systems built much of the Gulf Coast and continue to be essential to the health of the Gulf ecosystem. Furthermore, the strategy encouraged the use of sediments in the Gulf to address coastal land loss through sustainable resource management, land rebuilding and restoration. Sediment resources in the Gulf of Mexico are used for many man-made construction and restoration projects. Access to large sand inventories is needed for emergency repair of beaches stemming from storms or for ongoing re-nourishment of beaches. Finer grain sediments can be used for marsh creation projects, and suitable clay resources are used for the construction and repair or enhancement of existing levees. Sand and sediment management along the Gulf Coast region is a major concern, especially in the context of increasing storm severity and land development. The Gulf of Mexico Alliance (GOMA) has developed a Gulf Regional Sediment Management Master Plan aimed at improving sediment management practices (GOMA 2009). In Mississippi a master plan for beneficial use of dredge material has been developed (GOMA 2011a) along with a Project Management Plan for selected beneficial use projects along the Mississippi coast (GOMA 2011b). In addition, Louisiana manages the Louisiana Sand Resources Database (LASARD) to aid in maximizing the use of sediment sources outside the system to implement projects included in Louisiana's Comprehensive Master Plan for a Sustainable Coast (CPRA 2012).

3.2.2 Hydrology and Water Quality

This section looks at the movement, distribution, supply, and quality of freshwater and coastal water resources within the nearshore and offshore environments of the northern Gulf Coast. Gulf Coast hydrology and water quality are mainly affected by freshwater inputs (from inland waters of the Gulf of Mexico Watershed) and the movement of salt water. Drainage into the Gulf of Mexico basin is extensive and includes 20 major river systems (>150 rivers) covering over 3.8 million square kilometers of the continental United States. Annual freshwater inflow to the Gulf is approximately 10.6×10^{11} cubic meters per year (280 trillion gallons). Eighty five percent of this flow comes from the United States, with 64% originating from the Mississippi River alone. The quantity and rate of freshwater inputs through contributing rivers can be altered by a number of natural and anthropogenic factors such as changes in rainfall and land cover; flood control practices; spillway operation; navigation structures such as locks, dams, weirs and other water control structures; consumption of freshwater by agriculture, municipal, and industrial interests; and the development of stormwater infrastructure. Freshwater inflows to the northern Gulf of Mexico contribute nutrients, sediments, and pollutants from upstream agriculture, stormwater runoff, industrial activities, and wastewater discharges. The influx of these constituents is further affected by currents and surface winds. In addition, the nearshore environment, including tidal marsh areas, has been physically modified (e.g., through channelization and canal construction), allowing saltwater intrusion, which impacts both surface and sub-surficial groundwater resources. These alterations can affect the influx of freshwater into the northern Gulf of Mexico resulting in alterations to salinity regimes in nearshore areas, and facilitating stratification, potentially increasing the frequency and magnitude of hypoxic events. On balance, the inflow of freshwater provides the freshwater and sediment inputs necessary for maintaining healthy nearshore salinity regimes and

coastal landscapes, and offshore currents generally improve water quality through mixing and dilution. However, offshore currents can also serve as a conduit for pollution that can contribute to water quality degradation.

The rest of this section describes freshwater and coastal water environments, hydrology, and existing major water quality issues.

3.2.2.1 Freshwater Environments

The freshwater environment includes groundwater and surface waters (e.g., lakes, rivers, streams) connected to the northern Gulf of Mexico. As demand for freshwater resources from river basins and underground aquifers continues to increase throughout the Gulf Coast, maintaining freshwater flow of sufficient quality and quantity into bays and estuaries becomes increasingly important.

Groundwater

Groundwater supply is contained within permeable geologic formations, or parts of formations, called aquifers. Key geologic features help identify the location and availability of groundwater. For example, groundwater is typically found in unconsolidated geologic materials that lie above bedrock (solid rock beneath a layer of soil). Subsurface geology controls the transport of groundwater by transmitting water through porous and permeable layers. Subsurface geology can also stop water flow with impermeable barriers or divert it through fractures and other conduits. Aquifers in the northern Gulf Coast region can be classified into two primary types: semi-consolidated sand and gravel aquifers, which are found in coastal areas in Texas, Louisiana, Alabama, and Mississippi; and unconsolidated sand and gravel aquifers at or near the land surface, which are primarily found in Florida (USGS 2013). Groundwater can either be linked to or isolated from surface water resources, depending on the location, depth, and geologic structure of the aquifer.

Surface Water

The fresh, surface waters that supply the northern Gulf Coast serve as freshwater reservoirs, maintain nearshore salinity regimes, and serve as sources of nutrients and sediment resources. Freshwater inflow can affect the location, extent, and variety of estuary and nearshore habitat, especially during flood runoff seasons when large amounts of land-based material are transported to coastal environments. The surface waters of the Gulf Coast are provided by an extensive network of lakes, rivers, freshwater springs, and streams that ultimately discharge into the northern Gulf of Mexico (Figure 3-2). The inflow of freshwater from these rivers mixes with saline Gulf waters and creates an ecologically and economically important estuarine habitat.

Surface water quality is affected by nonpoint sources of pollutants such as agricultural and urban runoff and contaminants released from point discharges including excess nutrients, metals, oil and grease, suspended solids, and biocides. Thermal effluents can also affect the quality of both fresh and marine habitats.

Surface water flow is being affected in the Gulf of Mexico region by hydrologic modification from such activities as diversions, ditching, channelization, damming and undersized culverts. Below we provide descriptions of some of the key freshwater hydrologic features of the northern Gulf of Mexico.

Mississippi River Basin

The Mississippi River flows approximately 2,300 miles from Lake Itasca, Minnesota to the Gulf of Mexico, covering a drainage area of approximately 1.2 million square miles. The Mississippi River Basin (MRB) drains 41% of the contiguous U.S. and contributes 90% of the freshwater entering the Gulf of Mexico (U.S. EPA 2011). Traffic on the river has increased erosion, turbidity, and re-suspended sediments (U.S. EPA 2011). The Mississippi River is a heavily engineered river containing dams, locks, and levees to aid and control its flow.

Freshwater outflow from the MRB enters the northern Gulf of Mexico through two deltas: the Mississippi River Plaquemines-Balize Delta southeast of New Orleans receives about two-thirds of the flow, and the Atchafalaya River/Wax Lake Delta about 125 miles west receives the other one-third of the flow (Committee on Environment and Natural Resources 2010). The Atchafalaya River has also undergone significant hydrologic alterations in the last century. Historically, the discharge from this river accounted for less than 15% of the discharges from the MRB (Dale et al. 2010). Over time, more water was diverted from the Mississippi River into the Atchafalaya River so that by 1960, 30% of MRB discharges were diverted through the Atchafalaya River.

The Mississippi and Atchafalaya Rivers are the primary sources of freshwater, sediment, nutrients, and pollutants to the continental shelf (Murray 1997). Their freshwater discharge in the Gulf of Mexico is dependent on climatic conditions, but generally peaks in the spring. The freshwater and nutrients are carried predominantly westward along the Louisiana/Texas inner to mid-continental shelf, especially during peak spring discharge. This seasonal delivery of nutrient-laden freshwater to the Gulf of Mexico fuels the seasonal occurrence of hypoxia (low oxygen) along the northwestern portion of the Gulf of Mexico. (Murray 1997).

Channelization and human modifications to the Mississippi and Atchafalaya rivers have negatively impacted natural deltaic cycles in Louisiana by reducing the sedimentary load delivered to state marshes. As a result, the natural processes of coastal land formation have been modified. Historically, a balance was maintained between wetland formation and loss from overbank sediment deposition in actively forming delta lobes and subsidence and deterioration processes in abandoned delta lobes. The suspended sediment load has been greatly reduced by dams on major tributaries, land use changes in the watershed, and alterations to the landscape such as flood risk reduction projects and navigation channels. Overbank flooding of the Mississippi River and its tributaries has been greatly restricted or eliminated, removing the source of sediment and freshwater that built and maintained coastal marshes relative to subsidence and eustatic (global effects on) sea-level rise.

The Gulf Intracoastal Waterway

The Gulf Intracoastal Waterway (GIWW) is a 1,100 mile long man-made canal running along the Gulf of Mexico coastline from Brownsville, Texas to Carrabelle, Florida (Alperin 1983). The GIWW links all of the Gulf Coast ports with the inland waterway system of the U.S. (Texas DOT 2005). The GIWW is the nation's third busiest waterway with the Texas portion handling over 58% of the GIWW traffic. However, the use, operation, and maintenance of the GIWW have impacted the entire northern Gulf. For example, the GIWW has led to erosion and the decline of wetland quality. Shoreline development along the GIWW and recreational boating use of the system create conflicts with commercial navigation. Construction of the GIWW has led to altered salinities within some lagoons and coastal water bodies

(reduction in some areas and increase in others), conveyance of salt water, intrusion of saltwater into local surficial aquifers, and increased water circulation and entrainment between inland water bodies and the Gulf of Mexico. Maintenance of the channels has also led to temporary increases in sedimentation and turbidity due to dredging and sediment placement activities.

3.2.2.2 Coastal Water Environment

The coastal water environment consists of both nearshore (e.g., estuaries, bays, bayous) and offshore (i.e., open ocean) environments of the northern Gulf of Mexico.

Nearshore Coastal Environment

Nearshore coastal environments encompass a broad range of habitats from inland, tidally influenced freshwater ecosystems to 600-foot-deep water off the Gulf Coast. This includes a variety of wetland and upland habitats including tidal marshes, salt pannes, tidal mud flats, swamps, pine savanna, maritime forests, dunes, and beaches. It also includes aquatic habitats such as estuaries, bayous, bays, SAV beds and the open overlying waters of the continental shelf. Estuaries are transitional mixing zones of freshwater and saltwater habitats. The northern Gulf of Mexico estuaries make up 42% of the total estuarine surface area in the continental U.S. (U.S. EPA 1999). The continental shelf is the gently sloping undersea plain, and is an extension of the continent's landmass under the ocean. The waters of the continental shelf are relatively shallow (rarely more than 500 to 650 feet deep) compared to the open ocean (thousands of feet deep) (Figure 3-1).

The nearshore coastal environment is characterized as a relatively shallow, open coastline with complex circulation patterns, weak tidal energies, generally warm water temperatures, seasonally varying stratification strength, and large inputs of freshwater (Committee on Environment and Natural Resources 2010). Nearshore coastal waters of the northern Gulf of Mexico are very productive and exhibit a wide range of chemical and physical characteristics, which are influenced by freshwater influxes. Seasonal cycles, storms, and hurricanes contribute to the variability in coastal Gulf systems (Livingston 2003). As noted above, nutrient concentrations in coastal waters are largely determined by the input of freshwater from riverine sources, but they are also affected by periodic upwelling events and onshore flow of deep, nutrient-rich water mediated by shelf circulation (Gilbes et al. 1996).

Hypoxia is a key water quality issue in the nearshore environment. Normal oxygen concentrations in the Gulf vary between 8 and 10 milligrams per liter (U.S. DOI 2010). However, a large area on the northern Gulf continental shelf exhibits seasonally depleted oxygen levels, leading to hypoxic conditions. Hypoxic conditions occur when oxygen concentrations fall below the level necessary to sustain most animal life, which is generally defined by dissolved oxygen concentrations below 2 milligrams per liter (Committee on Environment and Natural Resources 2010). Hypoxia in the Gulf of Mexico is caused by freshwater discharge and nutrient loading from the Mississippi River, nutrient-enhanced primary production (i.e., eutrophication), decomposition of biomass on the ocean floor, and depletion of oxygen due to water column stratification in the Gulf of Mexico. Hypoxia is known to occur in at least 105 distinct locations within Gulf of Mexico estuaries (NOAA GOM at a Glance Report 2011a) (Figure 3-3). Oil and gas exploration, natural seeps, and chlorinated agricultural pesticides also contribute to hypoxic conditions (Turner et al 2003).

Offshore Marine Environment

The offshore marine environment consists of portions of the Gulf of Mexico that are more than 600 feet deep including the outer shelf, continental slope, and abyssal plain. These environments are further removed from the coast and thus less influenced by freshwater inputs. The outer shelf is a transition area between deepwater currents over the continental slope (steep slope from the continental shelf to the ocean floor) and the abyssal plain (the ocean floor offshore) (BOEM 2011). Water at depths greater than 4,500 feet is relatively homogeneous with respect to temperature, salinity, and oxygen (Nowlin 1971, Pequegnat 1983, and Gallaway and Kennicutt 1988, as cited in MMS 2007). Waters in the open, pelagic Gulf, along the outer continental shelf and further offshore are generally clear with low nutrient concentrations and deep light penetration, generally to around 600 feet (Jochens et al. 2005).

3.2.3 Air Quality

The Clean Air Act (CAA) has established National Ambient Air Quality Standards (NAAQS) to protect public health and welfare, including ecosystems, from air pollution. The NAAQS establish threshold concentrations for six 'criteria pollutants': nitrogen dioxide, sulfur dioxide, particulate matter (PM_{10} & $PM_{2.5}$), carbon monoxide, surficial ozone (O_3), and lead. The Gulf of Mexico air quality can be described by comparing measured, ambient air concentrations of these criteria pollutants for each of the Gulf States to the NAAQS.

All of the Gulf Coast counties meet the NAAQS for nitrogen dioxide, sulfur dioxide, carbon monoxide, particulate matter, and lead. However, the Houston-Galveston-Brazoria area has been listed by EPA as nonattainment for existing ozone standards (U.S. EPA 2013) (IPCC 2013).

In addition to the CAA mandates, Council on Environmental Quality (CEQ) draft guidance advises Federal agencies to consider opportunities that reduce greenhouse gas (GHG) emissions caused by proposed Federal actions and adapt their actions to consider climate change impacts throughout the NEPA process (CEQ 2010).

3.2.3.1 Climate

A region's climate is defined by temperature, wind patterns, humidity, and rainfall. These weather patterns are what ultimately define a region's freshwater supply, freshwater flow, and seasonal plant and animal presence and productivity. It is important to consider the existing climate in the Gulf of Mexico to understand how climate and projections of climate change may inform restoration planning (for more detailed information see Chapter 6).

The climate of the Gulf coast is moderated by sea surface temperatures and air flows from the Gulf of Mexico, Caribbean Sea, and the Atlantic Ocean. The Gulf coast can generally be characterized as a maritime subtropical climate with hot and humid summers and mild winters. Temperatures in July and August range from an average low of 77° to an average high of 91 degrees Fahrenheit (°F) (BOEM 2011). Average high winter temperatures range from approximately 50°F in the northernmost areas of the Gulf coast to about 70°F in the southernmost locations in Texas and Florida (BOEM 2011).

Wind patterns resulting from the Gulf and Atlantic oceans provide a major source of moisture and precipitation for the region. Rainfall is primarily driven by storm fronts in the winter and spring and thunderstorms, tropical storms, and hurricanes in the summer and fall. The amount of rainfall and/or

snowmelt dictates the amount of freshwater that drains into the Gulf of Mexico. This freshwater mediates salinities but also serves as a source of valuable nutrients and sediment. The Mississippi River Basin (MSR) and small, coastal watersheds drain to the Gulf of Mexico. The Mississippi River Basin (MSR) has an average annual rainfall of 34 inches which provides 90 % of the freshwater discharged into the Gulf of Mexico (Milly and Dunne 2001; Dale et al. 2010). Average annual rainfall along the Gulf coast watersheds varies from west to east ranging from 30 inches along parts of the Texas Gulf Coast to 60 inches in the Florida Panhandle.

Tropical cyclones, or hurricanes, are a storm system characterized by a low-pressure center surrounded by a spiral arrangement of thunderstorms that produce strong winds and heavy rain. These storms occur most frequently between June and October, with the worst storms usually in August and September. Between 1950 and 2005 an average of three tropical cyclones per year affected the Gulf of Mexico. Between 1995 and 2005 the annual average increased to six tropical cyclones affecting the Gulf of Mexico (U.S. EIA 2006).

3.2.4 Noise

The primary sources of terrestrial noise in the coastal environment are transportation and construction-related activities. Transportation noise includes traffic noise from automobiles, trucks, and motorcycles; railway transportation services; and aircraft (including helicopters) take-offs, landings, and overflights from public and private airfields. Construction noise is created during a variety of activities, including but not limited to, construction and demolition projects, site preparation (e.g., land clearing, grading, excavation), and repair and maintenance activities. These actions can result in relatively high noise levels within several hundred feet of the activity. Noise levels generated can fluctuate depending on the type, number, and duration of use of heavy equipment for construction activities and can differ in effect by the type of activity, existing site conditions (vegetation to buffer sound) and existing ambient noise levels.

In the marine environment, underwater sound spreads out in space, and is reflected, refracted (changed in direction), and absorbed. Several important factors affecting sound propagation in water include spreading loss, absorption loss, scattering loss, and boundary effects of the ocean surface and the bottom (Greene 1995). Natural sources of noise in the Gulf of Mexico marine environment include wind and waves, seismic noise from volcanic and tectonic activity, precipitation, and marine biological activities (Greene 1995). A wider range of ambient noise levels occurs in water depths less than 600 feet (shallow water) than in deeper water.

In addition to ambient noise, some sounds are also introduced into ocean environments from anthropogenic sources. These may include transportation (e.g., aircraft, small and large vessels, and hovercraft), construction activities (e.g., dredging, tunnel boring, and pile-driving), hydrocarbon and mineral-related activities (e.g., oil and gas exploration, drilling and production), geophysical surveys (e.g., air guns, sleeve guns, or vibroseis), the use of sonar and pingers for navigation and target detection, explosions (e.g., military ordnance, ship and weapons testing, and offshore demolition), and the conduct of ocean science studies (e.g., seismology, acoustic propagation, and acoustic thermometry).

3.3 Biological Environment

The northern Gulf of Mexico contains a range of habitats that support diverse and productive ecosystems with both nursery and feeding grounds for ecologically and economically important species (GCERTF 2011). These habitats and species are connected through the movement of organisms (population and genetic connectivity) and the exchange of nutrients and organic matter (horizontally from nearshore to offshore, and vertically from the surface waters to the ocean floor). Habitats, resources, and their ecological connection are all part of the biological environment of the northern Gulf of Mexico. The following description of the biological environment is divided into two sections: habitats and living coastal and marine resources.

Note: The following discussion of natural resources, and natural resource services, in the northern Gulf of Mexico is not intended to be a precise, definitive, or complete survey of those resources or resource services, nor is citation to a particular source meant to suggest a preference for the information in that sources vis-à-vis other sources of similar information. Rather, the following discussion is intended to give a general sense of the type and scale of natural resources, and accompanying natural resource services, found in the northern Gulf of Mexico.

3.3.1 Habitats

The northern Gulf Coast contains a variety of habitats including wetlands (e.g., mudflats, salt pannes, tidal flats, forested wetlands, pine savannas, riparian forests, swamps, and mangroves), barrier islands, beaches and dunes, submerged aquatic vegetation beds, and other habitats in the coastal environment. These habitats are ecologically, economically, and culturally important. For example, approximately 97% of all fish and shellfish harvested from the northern Gulf of Mexico rely on coastal estuarine habitat during spawning or during other parts of their life cycle (NOAA 2010). Figure 3-7 identifies habitat areas of particular concern in the Gulf of Mexico.

3.3.1.1 Wetlands

Wetlands are defined by Cowardin et al. (1979) as transitional lands between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is covered by shallow water. According to scientific classification, wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes (water loving plants); (2) the substrate is predominantly undrained hydric soil; or (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year. Wetlands include marshes (saltwater, brackish, and freshwater), mudflats, salt pannes, tidal flats, forested wetlands, pine savanna, riparian forests, mangroves, and swamps. Coastal wetlands[4] comprise millions of acres of habitat for aquatic and terrestrial organisms that are ecologically and economically important to the Gulf Coast region. Coastal wetlands can be created by natural deltaic cycles and floodplain dynamics. For example, the majority of Louisiana's coastal wetlands were built by deltaic processes of the Mississippi River (U.S. Army Corps of Engineers [USACE] 1997).

[4] In MS "coastal wetlands" are specifically defined as publicly-owned lands subject to the ebb and flow of the tide, which are below the watermark of ordinary high tide; all publicly-owned accretions above the watermark of ordinary high tide; and all publicly-owned submerged water-bottoms below the watermark of ordinary high tide, including the flora and fauna in the wetlands (MS Code § 49-27-5(a)).

Description and Ecological Importance

Both tidal and non-tidal wetland habitats provide a wide variety of ecosystem services. Specifically, wetlands provide habitat and foraging grounds for a variety of organisms; protect water quality by capturing suspended sediment and removing excess nutrients and pollutants from upland environments; prevent pollutants from reaching other habitats (Fisher and Acreman 2004; Bricker et al. 1999); have the ability to store and sequester carbon (Chmura et al. 2003; Choi and Wang 2004); and can buffer energy to protect coastal areas against storm surges. In addition, wetlands can decrease flooding through water storage after heavy rainfall. Wetlands provide habitat for countless bird, fish, and native plant species, and serve as a nursery for important recreational and commercial marine species.

Many coastal wetlands in the Gulf Coast region have been designated as one or more types of Essential Fish Habitat (EFH). Figure 3-4 presents a composite of EFH for Brown, Pink, and White Shrimp. EFH for shrimp consists of Gulf of Mexico waters and substrates extending from the US/Mexico border to Fort Walton Beach, Florida from estuarine waters out to depths of 100 fathoms; waters and substrates extending from Grand Isle, Louisiana to Pensacola Bay, Florida between depths of 100 and 325 fathoms; waters and substrates extending from Pensacola Bay, Florida to the boundary between the areas covered by the Gulf of Mexico Fishery Management Council and the South Atlantic Fishery Management Council out to depths of 35 fathoms, with the exception of waters extending from Crystal River, Florida to Naples, Florida between depths of 10 and 25 fathoms and in Florida Bay between depths of 5 and 10 fathoms (GMFMC 2005). EFH for red drum; reef fish; and coastal, migratory, and pelagic species are included in Figure 3-5. Appendix A.2 describes this habitat in more detail. EFH includes all types of aquatic habitats that a managed species requires to spawn, breed, feed, or grow to maturity (NOAA Fisheries Service 2013). Wetland habitats, including tidal and non-tidal marshes, tidal flats, and mangrove swamps, are habitats utilized by many pelagic fish species for spawning, breeding, or growth to maturity (NOAA Fisheries Service 2010).

Wetlands in the northern Gulf of Mexico region also support turtles, mammals, and other taxa in addition to extraordinary bird species diversity. These habitats are especially important for birds since portions of three major bird flyway corridors occur within the Gulf – the Central, Mississippi, and Atlantic (USACE 2009), as shown in Figure 3-6.

Wetland loss in the northern Gulf of Mexico region has occurred at some of the highest rates documented within the United States. Between 2004 and 2009, there was a loss of over 257,153 acres (~1.6%) of wetlands in coastal watersheds adjacent to the Gulf of Mexico. Conversion of estuarine marshes to open water can be attributed to sea level rise, land surface subsidence and erosion. Freshwater wetlands in the northern Gulf of Mexico region continue to be lost to development and agriculture (Dahl and Stedman 2013).

Distribution

Coastal wetlands are found in all five Gulf States. The northern Gulf of Mexico shoreline has more wetlands than either the Atlantic or Pacific coastlines and is recognized for its vast coastal tidal wetlands (saltwater and estuarine marsh environments). The coastal watersheds with the highest densities of wetlands (greater than 32%) occur along southern Louisiana, Mississippi, and Alabama (Stedman and Dahl 2005).

Mudflats in the northern Gulf can be found throughout the Mississippi River Delta and in the intertidal zones of all five Gulf States. Though fairly continuous in south Texas (Corpus Christi Bay to Mexico) and in south Florida, particularly near the Everglades, mangroves are also found sporadically in the more northern latitudes of the Gulf Coast. The five states located along the northern Gulf Coast contain a variety of non-tidal wetlands commonly found in floodplains along rivers and streams, in isolated depressions surrounded by dry land, and in other low-lying areas (Gulf Restoration Network 2001).

3.3.1.2 Barrier Islands

Barrier islands are coastal landforms consisting primarily of unconsolidated deposits of sediments that tend to be oriented parallel to the coastline. Barrier islands can protect wetlands and other estuarine habitats from the direct impacts of the open ocean. They also slow the dispersal of freshwater into the Gulf of Mexico, thus contributing to the total area and diversity of estuarine habitat (BOEM 2012).

Description and Ecological Importance

Barrier islands consist of beaches (ocean front and, in some places, landward), dune complexes, barrier flats, and back barrier marshes. Often seagrasses are present in waters behind these islands where wave energy is lower. Beaches are generally located on the ocean side of a barrier island where the most influential processes of deposition and erosion occur, and are discussed in more detail in section 3.3.1.3. Inshore of beach areas, one or more low dune ridges may be formed by the action of wind on sand. Sand dunes act as buffers against high winds and waves and as a reservoir for sand that can replenish beaches and back-barrier habitats during severe storms. Dune vegetation, such as sea oats and seacoast bluestem, has extensive root systems that can trap sand and promote dune building. Dune vegetation is adapted to the constant movement of sand, tidal flooding, and the high salt content of the substrate. Generally, succulent species (e.g., glassworts and saltworts) and vines are found on the beach fronts and wiregrass on highest dunes (LDWF 2012a). On larger barrier islands, secondary dunes form behind primary dunes. Secondary dune ridges are more heavily and diversely vegetated. Stable back dune areas can give rise to scrub communities built upon sandy or well-drained soils, with the predominant vegetation being herbaceous shrubs, evergreen oaks, or pines (BOEM 2012).

Barrier islands are often configured in chains that are separated from the mainland by a shallow sound, bay, or lagoon. The islands are typically separated by tidal inlets or passes (NOAA 2012a). The morphology of barrier islands is constantly changing in response to underlying geology; erosion; and deposition processes such as wind, currents, storm surge, overwash, sediment supply and transport. Movement of barrier islands may be landward, seaward, or laterally along the coast (BOEM 2012).

Barrier island systems provide habitat for many species of plants and wildlife, including important nesting areas for seabirds and sea turtles, and are vulnerable to human impacts. Barrier islands protect wetland systems that form along the islands such as lagoons, estuaries, and/or marshes by limiting erosion caused by daily ocean waves and tides as well as ocean storm events (Stone and McBride 1998). Coastal communities that have developed along the northern Gulf of Mexico are also afforded protection from coastal storms, surges, and tidal flooding by the presence of barrier land forms.

Stressors that impact the longevity and resilience of barrier islands in the northern Gulf Coast area include storm events, reduction in sediment supply, channelization, salt water intrusion, sea level rise,

and invasive species. Reduction in barrier islands has resulted in increased loss of coastal wetlands and stress to marsh ecosystems due to greater wave and current action.

Distribution

Barrier islands along the northern Gulf of Mexico are found from Texas to Florida. Eight geographically distinct barrier island systems have been characterized for the Gulf of Mexico from west to east: (1) the lower Texas coast (Laguna Madre and Padre Island); (2) mid-Texas coast (Mustang Island to Matagorda Peninsula); (3) upper Texas coast (Cedar Lakes to Bolivar Peninsula); (4) the deltaic barrier islands of southeast Louisiana from Atchafalaya Bay to Chandeleur Sound; (5) Mississippi Sound and Mobile Bay barrier islands (Cat Island to Bon Secour Peninsula); (6) Northwest Florida barrier islands from Pensacola to Cape San Blas; (7) southwest Florida barrier islands (Anclote Key to Marco Island); and (8) Florida Bay (Ten Thousand Islands and the Florida Keys) (GOMA 2009; University of Texas 2012; TPWD 2012a; NOAA 2012b). Two areas of the northern Gulf of Mexico coastline within the U.S. have no barrier islands: the Chenier Plain of southeast Texas and southwest Louisiana (High Island, Texas to Vermilion Bay, Louisiana) and the Big Bend area of Florida from Apalachee Bay to Anclote Key. Certain of these systems are discussed below.

The Laguna Madre system is located along the southern coast of Texas, extending about 285 miles along the coast of the Gulf of Mexico (Oceana 2012). The northern part of the lagoon is located in Texas and is separated from the Gulf by a long, thin barrier island, Padre Island. Stretching 113 miles from Port Isabel to Corpus Christi, Padre Island is the longest barrier island in the U.S., and an 80-mile-long segment is designated as a National Seashore (Weise and White 1980). Mustang Island, San Jose Island, and Matagorda Island and Peninsula extend across the Coastal Bend region. Galveston Island is on the upper Texas coast and is developed. Bolivar Peninsula is also on the upper Texas coast, but is more remote and contains extensive wetlands (Gibeaut and Crawford 1996).

Major barrier islands in Louisiana include the Chandeleur Island chain, Grand Isle, Grand Terre, Shell, Chenier Ronquille, Pelican, Scofield Islands, and Timbalier Islands, and Isle Derniéres. The Chandeleur Island chain contains Breton National Wildlife Refuge which is managed by the U.S. Fish and Wildlife Service to provide sanctuary for nesting and wintering seabirds, protect and preserve the wilderness character of the islands, and provide sandy beach habitat for a variety of wildlife species. The Terrebonne Barrier Islands Refuge, which is owned and managed by LDWF, consists of five barrier islands in the Isles Derniéres Chain: Wine, Whiskey, East, Trinity and Raccoon Islands. Over the past decade or so, State and Federal agencies have been working to restore barrier islands along the Isle Derniéres, Timbalier, and Barataria Bay Basin shorelines.

In Mississippi, there is an extensive barrier island system. Ship, Horn, and Petit Bois Islands are partly public lands managed under the Gulf Islands National Seashore. Cat Island is located between the Mississippi Sound and Chandeleur Sound, and a portion of the island is within the Gulf Islands National Seashore (GulfBase 2012). The remainder of the island is State and privately owned.

In Alabama, Dauphin Island, which is mostly privately owned, protects the mainland marshes of lower Mobile County such as Grand Bay and Point aux Pins. Dauphin Island is found to the east of Mississippi's Petit Bois Island and extends to Pass Aux Herons on southwestern Mobile Bay near Cedar Point.

Florida barrier islands occur along the southwest coast north of the Everglades, except in the Big Bend area (from Apalachee Bay to Anclote Key) where, because of low energy and minimal erosive forces, no barrier beaches are found. The Florida barrier islands are considered stable compared to those found off the other Gulf States (BOEM 2012). Barrier islands in the Florida Panhandle including Perdido Key, Dog, St. George, St. Vincent, Shell, and Santa Rosa Islands, are 99% quartz sand and were originally deposited by rivers draining the Piedmont. Parts of Perdido Key and Santa Rosa Island are protected within the Gulf Islands National Seashore.

3.3.1.3 Beaches and Dunes

Beaches are defined as land covered by unconsolidated, sand-sized material with minimal vegetation, extending landward from the low water line to dunes or a place where there is a distinct change in material or physical features. Dunes are wind-blown deposits of sand that form just behind the beach face and separate the higher energy beach from lower energy habitats, such as barrier flats, wetlands and mudflats. Beaches, dunes, and swale wetlands are ecologically and recreationally important shoreline habitats.

Description and Ecological Importance

Beach sediments along the Gulf Coast vary between geographic regions, but are composed primarily of inorganic quartz from weathered continental rock (Brown et al. 1990, Finkl 2004, and U.S. EPA 2004 as cited in Thayer et al. 2003). Estuarine beaches along the bay systems in the northern Gulf contain a higher content of organic matter in the sand than coastal beaches as a result of riverine sediment deposition. Beach habitats are dynamic environments that undergo significant change throughout the year. Accretion occurs in the summer as a result of reduced wave energy with erosion processes increasing in the winter due to increased high-energy wave action. These physical processes often lead to seasonal changes in the diversity and abundance of organisms.

Primary dunes in a beach system incur most of the saline and thermal stress from coastal physical processes, and as a result, vegetation diversity is generally lower on primary dunes than secondary dunes. The latter lie landward of the primary dunes, are older, more stable, and support more diverse and larger types of vegetation such as shrubs and small trees. A swale wetland typically forms in between primary and secondary dunes and acts as a catch basin for water that breaches the primary dune. Vegetation growing in the swale tends to be more tolerant of saltwater inundation. Typical dune plants along the Gulf of Mexico include sea oats, beach morning glory, bitter panicgrass, and cordgrass species.

Beaches are important breeding, nesting, wintering, and foraging habitats for a variety of species. Several species of sea turtles nest on some beaches of the northern Gulf Coast of Mexico (see section 3.3.2.6). Many birds, including federally listed, candidate and migratory species, such as piping plover and red knot, use beaches as important wintering and migratory habitats. Other species, such as Wilson's plover and snowy plovers use beaches as important breeding habitat. For example, coastal beaches are home to approximately 70% of the wintering population of the threatened piping plover (Elliott-Smith et al. 2009 as cited in Brown et al. 2011). Gulls and pelicans are also commonly found on Gulf beaches. Dune habitats support many different species, including federally listed species such as beach mice (see section 3.3.2.9). In addition, beaches provide habitat for a range of burrowing invertebrates and meiofauna (microscopically small benthic invertebrates).

Gulf coast beaches and dunes face a variety of threats including development pressure, sea level rise, sediment deficiencies, and habitat sustainability. Coastal population growth and the increasing economic development of ports, refineries, and industries have exacerbated these trends. The highest rates of erosion in the Gulf of Mexico region occur in Louisiana along barrier island and headland shores near the Mississippi delta. In Texas, erosion is rapid along the barrier islands and upper coast headlands. The Mississippi barrier islands are eroding and migrating laterally. The highest rates of erosion in Florida are generally found along the panhandle barrier island beaches and near tidal inlets. The most stable Gulf beaches are along Florida's west coast where low wave energy and beach nourishment minimize erosion (Morton et al. 2004). In addition to the long term shoreline change trends, anthropogenic modifications have created pockets of accretion and increased erosion in each of the Gulf States.

Currently, inland damming of rivers, creation of jetties, seawalls and other hard structures, and construction of structures in response to shoreline changes, has substantially altered the natural beach and dune processes. In addition to the direct impacts, these factors have reduced the Gulf Coast's capacity to adapt to large-scale changes in conditions caused sea level rise and coastal storms (McKenna 2009).

Distribution

Sandy beach and dune habitats are found along the coastline of all five Gulf States. The amount of sandy shoreline in each state is dependent upon the physical conditions at the area (e.g., wave action, sediment supply, etc.) and the level of coastal development.

3.3.1.4 Submerged Aquatic Vegetation

Submerged Aquatic Vegetation (SAV) describes plants that have adapted to living in or on aquatic environments. SAV includes seagrasses, oligohaline grasses, attached macroalgae, and drift algae. Due to the prominence of seagrass in Gulf Coast habitats, seagrass and SAV will be used interchangeably in the discussion below.

Description and Ecological Importance

Seagrasses are rooted vascular plants that grow in coastal waters and can, except for some flowering structures, live and grow below the water surface. Freshwater and brackish species are important components of estuary systems and inland waters. Seagrasses grow in the littoral (intertidal) and sublittoral (subtidal) zones in salinities ranging from freshwater to saltwater (>32 ppt). In the Gulf of Mexico, seven species of seagrasses are common (Table 3-1). A detailed description of these species is included in Appendix A.3.

SAV provide habitat, food, and/or shelter for birds, fish, shellfish, invertebrates, and other aquatic species, and are among the most productive habitats in coastal areas. SAV species filter contaminants and sediments; improve water quality; regenerate and recycle nutrients; and produce, export, and accumulate organic matter. Complex structures of seagrass leaves, roots, and rhizomes attenuate waves, reduce erosion, and promote water clarity while increasing bottom area habitat where communities of benthic organisms can live. SAV coverage has declined in most areas within the Gulf of Mexico due to natural and human-induced stressors including reduced light and water clarity, increased nutrient loading, and physical disturbance caused by dredging, boat propellers, anchors and groundings.

Distribution

It is estimated that there are over three million acres of SAV, both marine and freshwater/brackish, in the Gulf of Mexico, making the northern Gulf of Mexico a globally important SAV area (NOAA 2011b). The northern Gulf of Mexico has four major types of marine habitat where seagrasses are present: (1) lagoons, which can be hypersaline, contain turtle grass, manatee grass, shoal grass, star grass, and widgeon grass; (2) shallow coastal areas that contain widgeon grass, turtle grass, manatee grass, shoal grass, star grass, and water celery; (3) back reefs (the portion of the coral reef ecosystem that extends from the coast to the reef crest) that contain turtle grass, manatee grass, and shoal grass; and (4) deep coastal areas that contain paddle grass and star grass, which are tolerant of less light. Although seagrasses can display vertical zonation, this is not the case for all locations. Turtle grass, manatee grass, and shoal grass are the dominant seagrass species in the Gulf of Mexico and can occur in single species stands, but often occur in intermixed beds (Short et al. 2007).

Table 3-1. Seagrass species in the Gulf of Mexico.

COMMON NAME	HABITAT NOTES	GEOGRAPHIC DISTRIBUTION
Manatee grass	Subtidal environments (deeper waters) of high salinities.	Mainly in southern Texas and Florida, portions of Louisiana and Mississippi.
Shoal grass	Often exposed during low tide. Early colonizer of impacted areas.	Most common in Mississippi and Alabama. Also occurs in Texas and Louisiana, and Florida.
Turtle grass	Temperature limited, deeper waters.	Most abundant and widely spread in Gulf. Distributed in portions of Texas, Louisiana, Mississippi, and Florida.
Widgeon grass	Grows in both freshwater and saline environments.	Widespread along Texas, Louisiana, and Florida, portions of Mississippi, and Alabama. Dominant in some areas of Louisiana.
Paddle grass	Can grow in turbid waters.	Portions of Florida.
Star grass	Small plant growing in shallow waters.	Widespread in Florida, also occurs in portions of Texas and Mississippi.
Water celery/Eel grass	Grows in shallow coastal embayments and prefers fresh to brackish waters.	Present in all Gulf states.

3.3.1.5 Other Habitats in the Coastal Environment of the northern Gulf of Mexico

Key habitats include riparian areas, cheniers, coastal prairies, wet pine savannas and grassland savannas. These areas provide habitat for endangered and threatened terrestrial species as well as for migratory birds for use as stopover and nesting habitat. These coastal transition zones are important areas in the face of sea level rise for allowing habitat retreat.

Description and Ecological Importance

Riparian habitats are vegetated, forested areas adjacent to streams, rivers, lakes, reservoirs, and other inland aquatic systems that affect or are affected by the presence of water (USACE 2001). They are ecologically diverse and are home to a wide range of plants, insects, and amphibians. Riparian vegetation often consists of a lush mixture of trees, shrubs, and herbaceous vegetation, while adjacent

terrestrial areas along the Gulf Coast are typically non-forested ecosystems such as grasslands (Fischer et al. 2001). Streamside forests and riparian areas help to create and maintain aquatic habitat by providing shade, food, and in-stream woody structure. These riparian habitats prevent soil erosion, can act as a nutrient sink by preventing excess nutrients from entering waterways, and can also help mitigate the effects of extreme weather events. Many existing riparian habitats, including associated wetlands and aquatic systems, are negatively affected by overgrazing, timber removal, flood-control, and nonpoint-source pollution (Fischer et al. 2001). Typical hardwood species are pecan, water oak, southern live oak, and elm, with some bald cypress located on larger streams (Omernik and Griffith 2008). Large portions of floodplain forests have been removed and land cover is now a mix of forest, cropland, and pasture (Omernik and Griffith 2008). Similar to other ecosystems discussed in this section, riparian habitats throughout the Gulf Coast and inland have been degraded by water management, land development, and invasion by nonnative species.

Cheniers are narrow stranded woodland ridges that parallel the shoreline and rise to about 5 feet in elevation (Omernik and Griffith 2008; Barataria Terrebonne National Estuary Program [BTNEP] 2012). Coastal chenier ridges are considered to be the most important habitat for many neotropical, migratory birds during fall and spring seasons. Currently only about five percent of the historical, natural chenier habitat remains, due to impacts associated with coastal and agricultural development (American Bird Conservancy 2003). The Texas-Louisiana Chenier Plain, extending roughly from East Bay to Vermilion Bay along the Gulf Coast, is the most prominent area of chenier habitat in the United States. The loss of this natural chenier habitat has prompted the Louisiana Natural Heritage Program to list these areas as imperiled to critically imperiled.

Wet pine savannas are unique wetland habitats characterized by sparse canopy cover dominated by long-leaf pine, cypress species, or slash pine; very little shrubby understory; and dense groundcover of herbaceous species. Fire plays an important part in the ecology of this ecosystem because it keeps canopy and shrub species from crowding out the herbaceous layer. In addition, the long-leaf pine requires fire for regeneration. Wet pine savanna occupies much less of its historic range and is now considered a habitat type of special concern due to the lack of fire, invasive species infestation, and/or hydrologic alteration. Many of the larger, original areas have been permanently degraded by bedding (in attempts to establish pine plantations) and ditching or tilling to create drier areas for many types of uses including pastures and sod farms (USFS 2005). In many cases, this has altered hydrology to adjacent estuarine and marine systems.

The Coastal Prairie is a habitat comprised of a grass and forb community whose composition and structure was maintained by periodic fire events. This prairie occurred primarily on clay to loam soils and contained a mixture of upland pimple mounds and ridges with a scattering of wetland potholes. Wetlands comprised 20 to 40 % of this landscape (Moulton et. al. 1997). The pimple mounds present in this ecosystem are now considered to be the result of bioturbation by pocket gophers over geologic time. These upland mounds contain unique plant communities and the burrows of the gophers provide habitat for many other animal species (Lacey, et. al. 2000, Johnson and Burnham 2012). The wetlands are very important for a variety of benefits including water quality, flood protection, and habitat for fish and wildlife species (Wilcox et. al. 2011, Forbes et. al. 2012, Moulton and Jacob 2000). Wetland dependent species of animals including migratory, e.g. wintering waterfowl, and resident, e.g. Mottled

Duck, birds depend on these matrices of upland and wetland habitat. The loss of this habitat type is primarily due to land conversion into crop production, drainage ditch infrastructure, and invasive species (USGS 2000).

Distribution

The most extensive riparian habitats in the southeastern U.S. are vast bottomland hardwood forests along broad river floodplains or alluvial valleys (Huffman and Forsythe 1981, Mitsch and Gosselink 1993 as cited in Fischer et al. 2001). Bottomland hardwood forests can be found in all five Gulf States (Omernik and Griffith 2008).

Cheniers are found along the Gulf Coast between Vermilion Bay, Louisiana, and the Bolivar Peninsula and East Bay, Texas (about 200 miles), and inland from the coast from about 10 to 40 miles (American Bird Conservancy 2003).

Wet pine savannas are unique wetland habitats that occur along the lower Gulf coastal plain from north central Florida to eastern Texas. The Grand Bay National Wildlife Refuge located in coastal Mississippi and Alabama preserves one of the largest remaining blocks of wet pine savanna, a critically endangered ecosystem (National Wildlife Federation 2012).

The Coastal Prairie once extended from western Louisiana into the mid coast of Texas and comprised over 6 million acres of grassland habitat. Only 1% of this habitat remains present in its historic range. These remnant coastal prairie areas can be found in areas where land leveling did not take place, where grazing lands were managed for forage, and in locations near urban areas. Many of these sites are heavily infested with the invasive shrub, Chinese tallow tree, but can be restored through herbicide application and maintained with prescribed fire and/or mowing.

3.3.2 Living Coastal and Marine Resources

The northern Gulf of Mexico supports more than 15,000 marine species, many of which are globally significant, in addition to many threatened and endangered terrestrial species (NOAA 2011a). Species diversity allows communities to more readily recover from perturbations, and increases productivity (in terms of biomass). Any changes in the health of these resources have the potential to disrupt the connectivity between resources in the Gulf (Brown et al. 2011).

3.3.2.1 Nearshore Benthic Communities

Nearshore benthic communities in the northern Gulf are largely composed of macroinvertebrate groups such as mollusks, sponges, polychaetes, and crustaceans. These diverse groups are found in habitats spanning from the intertidal zone to the soft sediments on the continental shelf. There are two main components to benthic communities– the infauna and epifauna. The benthic infauna includes worms, mollusks, and crustaceans that live in bottom sediments. These species maintain sediment and water quality and provide a food source for bottom-feeding fish, shrimp, and birds. The benthic epifauna includes commercially important shellfish and finfish that live on the surface of bottom sediments. This section presents a description of the key benthic resources of the Gulf, their ecological importance, and their distribution among Gulf habitats.

Description and Ecological Importance

Sponges, mollusks (e.g., clams and oysters), arthropods (including crustaceans such as blue crabs and shrimp), and polychaetes are all important taxa and contribute substantially to benthic biomass and productivity. Mollusks and crustaceans are important ecologically and commercially throughout the northern Gulf Coast region.

These taxa include many species that are filter feeders. Filter feeders remove and digest phytoplankton and particulate organic matter, and deposit processed materials on the substrate (Turgeon et al. as cited in Felder and Camp 2009). Some benthic fauna form habitats (such as oyster reefs) that harbor diverse microbial communities, and provide habitat and nursery areas for fish and crevices for mobile invertebrates to seek shelter (Taylor et al. 2007). In addition, benthic organisms, like mollusks, are important in marine food webs.

Mollusks are soft-bodied animals that may have a hard, external shell composed of calcium carbonate, a hard internal shell, or no shell at all. Mollusk taxa include larger, commercially important organisms such as clams, scallops and squid, along with snails, slugs, whelks, and other cephalopods (squid, cuttlefish, and octopi). Mollusks are an important food source to many larger benthic and pelagic species. Two main subgroups of mollusks are gastropods and bivalves. The eastern oyster is the predominant commercial bivalve species in the Gulf (Section 3.3.2.2).

Crustacea is a class of diverse organisms that vary in many ways including size, mobility, feeding strategy, and habitat preference. There are over a dozen subgroups of crustaceans within the Gulf of Mexico (Felder and Camp 2009). Smaller crustaceans such as isopods, amphipods, and tanaids are ecologically important and have large populations within the northern Gulf. Larger crustaceans include shrimps, crawfishes, lobsters, and crabs.

Distribution

Sponges are found throughout the northern Gulf on substrates that include reefs, mangrove roots, seaweed, and artificial structures (e.g., oil platforms). Mollusk species are found attached to rocks and shells, on seagrass blades, on plant stems and roots, burrowed into sediment and other substrates and moving freely on the ocean floor and water column. Polychaetes are present in nearly all marine environments and are common in the sandy and muddy substrates of the Gulf; many species use the soft sediment to create burrows. Shrimp are widely distributed among the Gulf habitats, ranging from estuaries to open water habitat on the continental shelf. Shrimp are also associated with EFH for many other important aquatic species such as red drum, reef fish, coastal migratory species, stone crab, blue crab, and spiny lobster. Crabs are bottom-dwellers in every type of habitat from the saltiest water of the Gulf to the almost fresh water of the back bays and estuaries, from the low tide line to waters 120 feet deep (Perry, H.M., and T.D. McIlwain 1986, TPWD 2013). Blue crabs, which are one of the primary species of commercial importance in the Gulf of Mexico, use a wide variety of benthic habitats throughout their life history. Offshore, high-salinity waters are used during early larval stages. Larvae then move into estuaries and use subtidal and intertidal mud flats, oyster bars, channel edges, tidal marshes, seagrass beds, and soft-sediment shorelines as they grow (NOAA 2012c).

3.3.2.2 Oysters

The eastern oyster is the primary oyster species found across the northern Gulf and is the major commercial species. Oysters are important as organisms and providers of habitat, with an integral role in the function and structure of estuarine ecosystems.

Description and Ecological Importance

The eastern oyster lives in shallow, well-mixed estuaries, lagoons, tidal sloughs of barrier islands, and oceanic bays. This species can be found from one foot above the mean low tide line to 40 feet below the mean low tide line and within the Gulf of Mexico is typically found at depths of 0 to 13 feet (Eastern Oyster Biological Review Team 2007).

Oysters are an ecological keystone species in most estuaries in the northern Gulf of Mexico, and oyster populations contribute to the integrity and functionality of estuarine ecosystems (Eastern Oyster Biological Review Team 2007). Self-sustaining oyster populations form reefs that are crucial components of estuaries: they improve water quality and recycle nutrients, provide structured habitat in predominantly soft-sediment environments (especially for secondary producers), and provide other important ecological services to the physical environment (e.g., acting as natural breakwaters, helping to prevent shoreline erosion) (Grabowski and Peterson 2007; Coen et al. 2007; Eastern Oyster Biological Review Team 2007; Gulf States Marine Fisheries Commission [GSMFC] 2012; Peterson et al. 2003).

Oyster reefs provide habitat for a large number of commercially and recreationally important fish species. The structural complexity of oyster reefs provides refuge, nursery areas, foraging grounds, and breeding grounds for fish (Grabowski et al. 2005; GSMFC 2012).

Distribution

In the Gulf of Mexico, oysters are distributed throughout the northern coastal environment and are found in higher abundance in nearshore, shallow, semi-enclosed water bodies close to freshwater sources (GSMFC 2012). Commercial landings of oysters provide some indication of their distribution in the region.

In 2012, the commercial landings of oysters were: Louisiana, 11,252,297 pounds; Texas, 5,817,194 pounds; Florida (west coast), 2,834,373 pounds; Alabama, 265,286 pounds; and Mississippi, 425,496 pounds. Oyster harvests represent a $64 million dollar industry in the Gulf of Mexico (NOAA 2012e) and account for more than 60% of the U.S. catch of oysters.

Estimates of oyster reef extent vary from year to year and are often reported as the reefs which are harvested, and do not necessarily include reefs that are closed due to pollution or other reasons (e.g., designated as part of marine sanctuaries or no-harvest spawner sanctuaries). Beck et al. (2009) published a global assessment of oyster reefs consisting of native oyster species based on data compiled over a period of years. The assessment included bays in the Northern Gulf of Mexico and was based on many different sources of information, including direct estimates of oyster and oyster reef distribution from multiple publications, historical maps, formal surveys of scientists and managers, fishery statistics, and literature reviews. They rated reef condition based on the percent of current to historical abundance of oyster reef remaining (compared to baselines measured from 20-130 years ago): <50% lost (good); 50 – 89% lost (fair); 90 – 99% lost (poor); and > 99% lost (functionally extinct). The

overall rating for the Northern Gulf of Mexico was fair[5], or 50- 89% lost compared to historical levels of abundance. However, even at this, the bays in the Northern Gulf of Mexico were rated in better condition than those in other parts of the continental U.S., which were generally rated as poor or functionally extinct with regard to native oyster abundance.

Approximate acreages of public and private leases for the Gulf states are as follows: Texas: public reefs 22,760 acres and private oyster leases 2,321 acres; Louisiana Department of Wildlife and Fisheries (LDWF) estimates there are nearly 1.7 million acres of public water bottoms, with a combination of production from private leases (approx. 80%) and pubic seed grounds (20%); Mississippi has about 12,000 acres of public oyster reefs, and very few leases; there are currently roughly 2200 acres of viable oyster reef in coastal Alabama; and Florida has about 8,000 – 10,000 acres, most of which is in Apalachicola Bay and St. George Sound (TPWD n.d., LDWF 2012, MDMR 2012b, NFWF 2013, and Kilgen and Dugas 1989).

3.3.2.3 Pelagic Microfaunal Communities

The upper water column in the nearshore coastal environment contains phytoplankton, zooplankton, micronekton, and neuston, collectively referred to as pelagic microfauna.

Description and Ecological Importance

Microfauna play an integral role in the Gulf food chain through both the production of food sources and the transfer of energy through trophic levels. Primary productivity (the production of new organic matter from photosynthesis) from near surface phytoplankton is transported to the sediments through the water column; however, much of this production is effectively consumed prior to reaching the bottom. Despite being generally oligotrophic (waters with low primary productivity), localized, offshore, deepwater areas of productivity do occur and contain a higher biomass of zooplankton and micronekton that contribute to secondary production (Biggs and Ressler 2001).

Distribution

Pelagic microfauna are distributed throughout the nearshore, shelf and offshore environment in the northern Gulf.

3.3.2.4 Sargassum

Sargassum is a genus of brown macroalga and a major component of the pleuston group in the offshore Gulf. The life history of sargassum is not well understood. Two pelagic species of *Sargassum* occur in the Gulf of Mexico, *Sargassum natans* and *Sargassum fluitans*, which support a diverse community of marine organisms.

Description and Ecological Importance

The pelagic *Sargassum* species are golden brown in color and typically 3.1 to 12.6 inches in diameter. *Sargassum* contains pneumatocysts, which are small vesicles that function as floaters to help *Sargassum* maintain positive buoyancy through the use of oxygen and nitrogen gas (SAFMC 2002). It normally occurs in small clumps, but under the right environmental conditions, can form large patches, mats, or

[5] The assessment did not include Louisiana bays.

windrows. In some instances these patches reach several acres in size and extend 10 feet deep. This alga supports a high diversity of marine invertebrates and vertebrates including several commercially and ecologically important pelagic fish, birds, and sea turtles. Over fifty-four species of fish are known to utilize *Sargassum* habitat for some portion of their life stages for shelter, feeding, spawning, and nurseries for juveniles. Commercially important species such as barracuda, mackerel, tuna and swordfish use *Sargassum* habitat for shelter and as foraging grounds, preying on small and juvenile fish (Coston-Clements et al. 1991). Juvenile sea turtles, including loggerhead turtles, green turtles, Kemp's ridley, and hawksbill turtles, use the *Sargassum* for protection and foraging grounds (Witherington et al. 2012). In addition, a wide variety of birds forage on invertebrates or small vertebrates found within *Sargassum* floating in the Gulf and washed up on beaches.

Distribution

Pelagic *Sargassum* shows a seasonal pattern of distribution and movement in the Gulf, with the northwestern Gulf being a major nursery area. Satellite imagery shows that *Sargassum* typically shows strong growth in the northwestern Gulf of Mexico in the spring of each year, and is transported to the Atlantic Ocean by about July (Gower and King 2008). It then travels east of Cape Hatteras and ends up north of the Bahamas by the following February. *Sargassum* is widely dispersed across the Gulf off Texas and Louisiana.

3.3.2.5 Finfish

The Gulf of Mexico supports diverse assemblages of fish that inhabit freshwater, estuarine, coastal, and marine habitats. This includes more than 15% of all known species of marine fish (McEachran and Fechhelm 1998). Fish assemblages vary based on salinity, temperature, depth, and substrate. The Gulf of Mexico has some of the most productive commercial and recreational finfish fisheries in the world.

Description and Ecological Importance

In the northern Gulf of Mexico, fish assemblages can be grouped by habitat use. Many pelagic and demersal fish inhabit coastal estuaries during their early life stages. Egg and larval stages of demersal fish often spend time in the upper water column where phytoplankton and zooplankton resources are concentrated, before ultimately moving to bottom waters. Some fish species have unique migratory patterns, spending most of their adult life in saltwater but spawning in freshwater (anadromous), or others that live primarily in freshwater and spawn in saltwater (catadromous), these two groups are collectively referred to as diadromous.

Fish populations in the northern Gulf of Mexico face a variety of stressors including fishing pressure, pollution, habitat degradation and loss, invasive species, and shifting environmental conditions. Fishing mortality, by either directed fisheries or as bycatch, is often the most dominant source of un-natural mortality. Changes in physical conditions in the marine environment can affect the growth, survival, and reproduction of many fish species. The spatial distribution of marine fish species is largely determined by climate. Factors such as air and water temperatures, ocean acidification, changes in runoff from the land, sea-level rise, and altered currents may also affect fisheries in the Gulf of Mexico (Karl et al. 2009).

Demersal Fish

Demersal fish in the northern Gulf of Mexico can be generally characterized as soft-bottom fish or hard-bottom fish, according to their association with particular substrate types. Soft-bottom habitat is

relatively featureless and has lower species diversity than the more structurally complex hard bottom habitat. Demersal fish associated with soft-bottom generally prefer certain types of sediments over others; this tendency has led to the naming of three primary fish assemblages according to the dominant shrimp species found in similar sediment/depth regimes (Chittenden and McEachran 1976; reviewed in GMFMC[6] 2004).

In the Gulf of Mexico, pink shrimp are found in waters up to about 148 feet over calcareous sediments. Common members of the pink shrimp assemblage include Atlantic bumper, sand perch, silver jenny, dusky flounder, and pigfish. Fishes associated with brown shrimp and white shrimp are found on more silty sediments. The brown shrimp assemblage extends to 299 feet. Examples of fish in the brown shrimp assemblage include porgies, searobins, batfish, lefteye flounders, cusk-eels, and scorpionfishes. The white shrimp assemblage exists in 11 to 72 feet of water, and dominant fish include drums, Atlantic croaker, snake mackerels, herrings, jacks, and flounders. Many fish species in the white and brown shrimp assemblages spawn in shelf waters and spend their early life stages in estuaries (GMFMC 2004).

The term “hard bottom” generally refers to exposed rock, but can refer to other substrata such as coral and clay, oyster reefs, or even artificial structures. Hard-bottom associated fish include most snapper and grouper. The GMFMC manages snappers, groupers, tilefishes, jacks, gray triggerfish, and hogfish under the reef fish fishery management plan. Other examples of reef fishes include sea basses, grunts, angelfishes, damselfishes, parrotfishes, and wrasses which inhabit hard-bottom habitats in the Gulf of Mexico (Dennis and Bright 1988). Although reef fish are associated with hard-bottom habitat as adults, some species can be found over soft sediments as well, such as porgies. Like soft sediment species, many hard-bottom demersal fish are estuarine dependent and spend their juvenile states in coastal habitats.

Pelagic Fish

Pelagic fish include larger predatory species such as mackerels and cobia and smaller forage species such as menhaden. Pelagic species in the Gulf also include highly migratory species managed by NOAA Fisheries such as tunas, swordfish, billfish and sharks (NOAA 2009). These species are found in federal waters throughout the Atlantic Ocean and the Gulf of Mexico. Billfish represent oceanic, epipelagic species that are occasionally coastal. Billfish typically do not school, but migrate extensively near the surface where they feed on pelagic fishes. Five species of billfish associated with the Gulf of Mexico are managed under Fishery Management Plans (Because swordfish and tunas are highly migratory species, the fishery is managed by NOAA Fisheries Service in coordination with the International Commission for the Conservation of Atlantic Tunas (ICCAT).

Fish inhabiting oceanic waters can be divided into epipelagic, mesopelagic, and bathypelagic, on the basis of their depth preference. Epipelagic fishes inhabit the upper 700 feet of the water column in oceanic waters, typically beyond the continental shelf edge (Bond 1996). In the Gulf of Mexico, this group includes several shark species, swordfish, billfishes, flyingfish, halfbeaks, jacks, dolphinfish, and tunas. A number of the epipelagic species, such as dolphin fish, sailfish, white marlin, blue marlin, and tunas, are in decline and have important spawning habitat in the Gulf of Mexico. All of these epipelagic

[6] Gulf of Mexico Fishery Management Council

species are migratory, but specific patterns are not well understood. Many oceanic species are associated with *Sargassum* spp., jellyfishes, siphonophores, and driftwood, because they provide forage and/or nursery habitat. Most fish associated with floating seaweed are temporary residents, for example, juveniles of species that reside in shelf or coastal waters as adults. Adult life stages of several larger species, such as dolphin fish, tuna, and wahoo, also feed on smaller juvenile fish attracted to *Sargassum* (GMFMC 2004).

Diadromous and Freshwater Fish

The coastal river systems of the Gulf generally have diverse assemblages of freshwater fish and invertebrates. Freshwater fish assemblages include sturgeons, gars, catfishes, sunfishes, bass, minnow, darters, killifishes, livebearers, and many others. Anadromous and catadromous fish, collectively referred to as diadromous, utilize both freshwater and saltwater to complete their life cycles. Some anadromous fish species in the Gulf of Mexico include Gulf sturgeon, striped bass, and Alabama shad; and some catadromous species include American eel and striped mullet.

Threatened and Endangered Fish Species

Fish species listed under the ESA within the northern Gulf of Mexico include: largetooth sawfish, smalltooth sawfish, and Gulf sturgeon (Table 3-2). Designated critical habitat for the Gulf sturgeon is presented in Figure 3-9.

Table 3-2. Potentially Affected Federally listed fish species found along and within the Gulf of Mexico.

SPECIES COMMON NAME	STATUS	USE OF GULF
Sawfish		
Smalltooth sawfish	Endangered	Sheltered bays, shallow banks, estuaries and river mouths along the Gulf of Mexico with muddy and sandy bottoms.
Largetooth sawfish	Endangered	Shallow estuarine and fresh coastal waters near rivermouths and large bays. Prefers semi enclosed water bodies.
Sturgeon		
Gulf sturgeon	Threatened	Anadromous. Migrates to large, free-flowing riverine habitats with hard or sandy substrates in breeding season (late spring to summer); returns to cooler estuarine and marine habitats in GOM during non-breeding season (early fall through early spring).
Source: NOAA 2012j		

The smalltooth and largetooth sawfish are listed as endangered due to their capture as bycatch in various commercial and recreational fisheries and to habitat loss and degradation. They occur in shallow, coastal waters within the Gulf and generally in nearshore habitats with muddy and sandy bottoms often in sheltered bays, estuaries (particularly mangroves), river mouths and mud banks (NOAA Fisheries Service 2009).

Gulf sturgeon is listed as threatened due to declines in its population related to the presence of dams and water control structures that block access to historical spawning habitats, loss of habitat, poor water quality, and overfishing (USFWS 1995). It spawns in areas of rock and rubble in coastal rivers from

Louisiana to Florida during the summer, and occurs in the Gulf and its estuaries and bays in the cooler months (USFWS 1995). Additional detail on these three species is presented in Appendix A.4.

3.3.2.6 Sea Turtles

There are five species of sea turtles found within the Gulf of Mexico, all of which are listed under the ESA. These include the green sea turtle, the hawksbill sea turtle, the loggerhead sea turtle, Kemp's ridley sea turtle, and the leatherback sea turtle.

Description and Ecological Importance

For most sea turtles in the Gulf (with the exception of the leatherback turtle), hatchlings develop in open ocean areas (i.e., continental shelf) and juvenile and adult turtles move landward and inhabit coastal areas. Leatherback turtles spend both the developmental and adult life stages in the open oceanic areas of the Gulf (BOEM 2012). Sea turtles nest on sandy beaches in some estuarine areas. For healthy Gulf sea turtles, onshore activities are typically limited to the nesting process.

Immediately after hatchlings emerge from the nest, they move to the surf, are swept through the surf zone, and continue swimming away from land for up to several days (NOAA Fisheries Service 2011a). Once hatchling turtles reach the juvenile stage, they move to nearshore coastal areas to forage. As adults, they utilize many of the same nearshore habitats as during the juvenile developmental stage. Sea turtles utilize resources in coral reefs, shallow water habitat (including areas of seagrasses), and areas with rocky bottoms.

Turtles maintain a variety of Gulf habitats including SAV beds and coral reefs. Grazing on SAV by turtles helps to increase nutrient cycling in those habitats and prevents an over-accumulation of decaying SAV on the seafloor (Thayer et al. 1984). Sea turtles can also help to maintain their nesting beaches through the provision of necessary nutrients to dune vegetation (Bouchard and Bjorndal 2000). In addition to maintaining habitats, sea turtles also aid in balancing the food web in their marine environments. Leatherbacks, for example, prey primarily upon jellyfish and help to prevent the proliferation of this group that can easily out compete fish species in the same area (Lynam et al. 2006). Turtles can also be prey to larger organisms. Hatchling and juvenile sea turtles are particularly vulnerable to predators in the offshore environment (Wilson et al. 2010). Sea turtles also provide food to smaller organisms; fish feed off of the barnacles and algae that turtles carry around on their shells, and without this source of food, many fish species would lose a primary food source (Bjorndal and Jackson 2003). Each species of sea turtle in the Gulf is unique and affects the diversity and function of their environment differently; however, all species of sea turtles are critical in maintaining the health, function, and resiliency of the Gulf ecosystem as a whole.

Primary threats to sea turtle populations include loss of coastal habitat (e.g., shallow coral and SAV), loss of foraging areas, nest predation, and impacts to nesting habitat by human use (NOAA Fisheries Service 2011b). In addition, sediment dredges as well as fishing take, which includes incidental capture in fishing gear, primarily in longlines and gillnets, but also in dredges, shrimp trawls, traps, fishing lines and pots, pose a threat to sea turtles. (NOAA Fisheries Service 2011a, 2011c, and 2011d).

Distribution

All five species of sea turtles are migratory and thus have a wide geographic range (BOEM 2012). Sea turtle species can use all areas of the northern Gulf and can nest on any beach with suitable conditions. While most nesting observed in the northern Gulf of Mexico occurs in Florida and Alabama, all five sea turtle species have been known to nest along areas of the Texas coast, particularly Padre Island National Seashore (NPS 2011 as cited in BOEM 2012). There have also been recent reports of nesting in Mississippi (loggerhead turtles) (BOEM 2012), and historic nesting reports in Louisiana. The northern coastal Gulf of Mexico is also an important foraging hotspot for juvenile Kemp's ridley turtles (Shaver et al. 2013).

Threatened and Endangered Sea Turtle Species

As mentioned above, all five species of sea turtles found in the Gulf of Mexico are listed under the ESA. Table 3-3 summarizes the status of listed sea turtles in the Gulf of Mexico. Appendix A.5 provides additional details regarding these species. The Gulf populations of green (breeding populations in Florida), hawksbill, Kemp's ridley, and leatherback sea turtles are listed as endangered. Loggerhead (northwest Atlantic distinct population segment) and green (except the Florida breeding population) sea turtles are listed as threatened.

Table 3-3. Threatened and endangered sea turtles of the Gulf of Mexico.

COMMON NAME	FEDERAL STATUS	USE OF GULF
Loggerhead sea turtle	9 Distinct Population Segments (DPSs) – 4 listed as threatened (Northwest Atlantic Ocean, South Atlantic Ocean, Southwest Indian Ocean, and Southeast Indo-Pacific Ocean DPSs) and 5 listed as endangered (Northeast Atlantic Ocean, Mediterranean Sea, North Pacific Ocean, South Pacific Ocean, and North Indian Ocean DPSs).	The Northwest Atlantic Ocean DPS uses shallow water habitats, continental shelf waters, open Gulf waters from Texas to Florida; nesting on Gulf Coast beaches in Florida, Alabama, Mississippi, and Texas. Records of historical nesting in Louisiana and Mississippi. Critical habitat has been proposed.
Green sea turtle	Breeding populations in Florida and on the Pacific Coast of Mexico are listed as Endangered; all others are listed as Threatened.	Inshore and nearshore waters from Texas to Florida; nests in Texas and Florida. Historically reported as nesting in Alabama (see figure 3-10 in chapter 3 for critical habitat).
Hawksbill sea turtle	Endangered	From Texas to Florida, particularly near coral reefs, in coastal and open Gulf waters; one record of nesting at Padre Island National Seashore, Texas; records of nesting in Florida (see figure 3-10 in chapter 3 for critical habitat).
Kemp's ridley sea turtle	Endangered	From Texas to Florida in coastal and pelagic waters; nesting on Gulf Coast beaches in Texas, and infrequently in Alabama and Florida.
Leatherback sea turtle	Endangered	Pelagic and coastal waters of the Gulf of Mexico; nests in Florida and incidentally in Texas (see figure 3-10 in chapter 3 for critical habitat).

3.3.2.7 Marine Mammals

Marine mammals found within the Gulf of Mexico include 21 species of cetaceans (whales and dolphins) and the West Indian manatee.

Description and Ecological Importance

Marine mammals are major consumers at multiple trophic levels. For example, herbivory by manatees influences composition of coastal seagrass communities (Bowen 1997). Cetaceans are divided into two groups: baleen whales and toothed whales, which also include dolphins and porpoises. Baleen whales feed on plankton and small fish by straining water through a net of plates (baleen) in their mouth. Toothed whales are active predators that capture prey items including fish and squid. The bodies of dead marine mammals support deep-sea communities, effectively linking the pelagic and deepwater ecosystems. All marine mammals are protected under the Marine Mammal Protection Act.

Distribution[7]

Cetacean distribution (Table 3-4) is affected by demographic, evolutionary, ecological, habitat-related, and anthropogenic factors (Bjørge, 2002; Bowen et al., 2002; Forcada, 2002; Stevick et al., 2002). Movement of individual marine mammals is generally associated with feeding or breeding activity (Stevick et al., 2002). For example, some baleen whale species make extensive annual migrations to low latitude mating and calving grounds in the winter and to high-latitude feeding grounds in the summer (Corkeron and Connor, 1999). Migrations probably occur during these seasons due to the presence of highly productive waters and associated prey species at high latitudes and of warm water temperatures for calving at low latitudes (Corkeron and Connor, 1999; Stern, 2002); however, not all baleen whales migrate. Some individuals, age classes, or subsets of a population may stay in one area year-round (Tershy et al., 1993; Notarbartolo-di-Sciara et al., 2003). Specific bathymetric and oceanographic features in the Gulf of Mexico attract and concentrate marine mammals. In the northern Gulf of Mexico, there are numerous cetacean sightings in waters over the continental shelf (particularly in nearshore waters), in the vicinity of the continental shelf break, over the continental slope, and out over the abyssal plain. Shallower waters over the continental shelf and inshore waters provide habitat for Atlantic spotted and bottlenose dolphins (Fulling et al., 2003; Mullin and Fulling, 2004).

Threatened and Endangered Marine Mammal Species

All marine mammals are protected under the Marine Mammal Protection Act of 1972 (MMPA) (16 United States Code [U.S.C.] 1361 *et seq.*). Six species of marine mammals in the Gulf are listed as threatened or endangered under the ESA including the West Indian manatee, blue whale, finback whale, humpback whale, sei whale, and sperm whales. The Sperm whale and West Indian manatee are designated as endangered under the ESA and depleted under the MMPA. Sperm whales are endangered because they are targeted by commercial whaling efforts that occur outside the U.S. (NOAA 2012f). The West Indian manatee is endangered because various human related activities have resulted in a small population size (less than 2,500 mature individuals exist in the population, which may be declining). Research indicates that the species could face at least a 50% future reduction in population size from

[7] The information regarding distribution of marine mammals was extracted from the Gulf of Mexico Range Complex Final Environmental Impact Statement/Overseas Environmental Impact Statement (Department of the Navy 2010).

human-related activities (USFWS 2001; FWC 2007). To assist in their protection, Florida enacted the Manatee Sanctuary Act in 1978 and declared the entire State of Florida to be a manatee "refuge and sanctuary" (FWC 2007). In Alabama, a number of manatees (one to fifteen individuals) are routinely seen in the calm, shallow waters of rivers and sub-embayments of Mobile Bay and the Mobile-Tensaw Delta. However, manatees have been observed in the coastal areas, off barrier islands, and up to 145 kilometers offshore (Pabody et al. 2009, Fertl et al. 2005). Manatees have been sighted in Mississippi and Louisiana (considered by the State to be endangered) typically in estuarine and river mouth habitats though there have been numerous sightings in Lake Pontchartrain, Louisiana and near barrier islands and offshore of both States (Fertl et al. 2005). There have been 127 sighting, carcass, and capture records documented between 1912 and 2004 along the coast of Texas (Fertl et al. 2005); however, due to a lack of seagrass foraging habitat, these manatees are thought to be transiting the area only.

Table 3-4. Marine mammals of the Gulf of Mexico.

COMMON NAME	ENDANGERED SPECIES STATUS	USE OF GULF
Baleen Whales		
Bryde's whale		Bryde's whales likely have a cosmopolitan distribution and occur in tropical and warm temperate oceans around the world. They can be found globally in all oceans from 40° South (S) to 40° North (N). It is the only baleen whale that regularly inhabits the Gulf of Mexico and has been regularly sighted in the northeastern Gulf of Mexico.
Toothed Whales		
Sperm whale	E/D	Sperm whales are found throughout the world's oceans in deep waters between about 60°N and 60°S latitudes and occur as an apparently native population or populations in the northern Gulf of Mexico near coastal waters just south of the Mississippi delta.
Pygmy sperm whale		Pygmy sperm whales have a cosmopolitan distribution in temperate and tropical seas worldwide. Sightings in the northern Gulf of Mexico occur primarily in oceanic waters.
Dwarf sperm whale		Dwarf sperm whales have a cosmopolitan distribution in temperate and tropical seas worldwide. Sightings in the northern Gulf of Mexico occur primarily in oceanic waters.
Melon-headed whale		Melon-headed whales are found primarily in deep waters throughout tropical areas of the world. Sightings of melon-headed whales were documented in all seasons during surveys of the northern Gulf of Mexico between 1992 and 1998.
Killer whale		Killer whales have a global but patchy distribution and can be found in large concentrations over the continental shelf.
Pygmy killer whale		Pygmy killer whales are found primarily in deep waters throughout tropical and subtropical areas of the world. Sightings of these animals in the northern Gulf of Mexico occur in oceanic waters in all seasons based on data collected during surveys of the northern Gulf of Mexico between 1992 and 1998.
False killer whale		False killer whales can be found in all tropical and temperate oceans worldwide; they occur in the U.S. in Hawaii, along the entire West Coast, and from the Mid- Atlantic coastal states south including the northern Gulf of Mexico.
Short-finned pilot whale		Short-finned pilot whales are found primarily in deep waters throughout tropical and subtropical areas of the world. Sightings in the northern Gulf of Mexico occur primarily on the continental slope and were made in all seasons during surveys of the northern Gulf of Mexico between 1992 and 1998.
Blainville's beaked whale		Blainville's beaked whales appear to be widely but sparsely distributed in temperate and tropical waters of the world's oceans. Their distribution is

COMMON NAME	ENDANGERED SPECIES STATUS	USE OF GULF
		cosmopolitan throughout the world's oceans.
Gervais' beaked whale		Gervais' beaked whales are distributed throughout deep, warm waters of the central and north Atlantic Ocean. This species is thought to occur mostly north of the equator.
Cuvier's beaked whale		Cuvier's beaked whales can be found in most oceans and seas worldwide
Dolphins		
Rough-toothed dolphin		Rough-toothed dolphins are found primarily in deep waters throughout tropical and warmer temperate areas of the world.
Risso's dolphin		Risso's dolphins have a cosmopolitan distribution in oceans and seas throughout the world from latitudes 60°N to 60°S. They occur in the nearshore waters of the Gulf of Mexico.
Bottlenose dolphin		Bottlenose dolphins are found in temperate and tropical waters around the world ranging from latitudes of 45°N to 45°S including the nearshore waters of the Gulf of Mexico.
Atlantic spotted dolphin		Atlantic spotted dolphins occur throughout the warm temperate, subtropical, and tropical waters of the Atlantic Ocean. They occur in the nearshore waters of the Gulf of Mexico.
Pantropical Spotted dolphin		The species can be found in all oceans of tropical and subtropical climate worldwide.
Spinner dolphin		The species can be found in all tropical and subtropical oceans. In most places, spinner dolphins are found in the deep ocean.
Clymene dolphin		Clymene dolphins have a widespread distribution throughout the warm waters of the equatorial Atlantic Ocean. They only occur in deepwater (820-16,400 ft).
Striped dolphin		Striped dolphins have a cosmopolitan distribution. They are mainly found in tropical and warm temperate waters seaward of the continental shelf from 50°N to 40°S. This species occurs in the U.S. off the west coast, in the northwestern Atlantic, and in the Gulf of Mexico.
Fraser's dolphin		Fraser's dolphins have a cosmopolitan distribution from 30°S to 30°N, and live in deep, tropical waters.
Manatees		
West Indian Manatee	E/D	The manatee population in the U.S. is concentrated in Florida; though individuals have been observed in waters around Alabama, Mississippi, Louisiana, and Texas. Manatees can be found in shallow, slow-moving waters of rivers, estuaries, bays, canals, and coastal areas where seagrass beds thrive.

E = Endangered as designated under the ESA.
D = Depleted as designated under the MMPA.
Note: Blank cell denotes that there is no Federal listing status for a species.
Source: NOAA 2011.

3.3.2.8 Birds

Many species of birds spend all or a portion of their life cycle along the Gulf of Mexico using a variety of habitats at different stages. Major groups of birds that inhabit the northern Gulf of Mexico include waterfowl and other water-dependent species, pelagic seabirds, raptors, colonial waterbirds, shorebirds, marsh-dwelling birds, and passerines. This section has been organized and subdivided to convey information on groups of birds that may be found at various times in these habitats. Several species have been presented in more detail within each of the major groups of birds discussed. Some species have been selected because they, or a large proportion of their population, are restricted to the

habitats of the northern Gulf of Mexico region during all or part of the year. Other species described are considered of conservation concern by Federal or State agencies.

Many bird species migrate between breeding and wintering habitat in the northern Gulf of Mexico. Parts of the Central, Mississippi, and Atlantic Flyways (well-described routes between wintering grounds and summer nesting grounds) are used by hundreds of millions of birds that converge on the Gulf Coast where they either migrate along the northern Gulf Coast before reaching their destination on the Gulf of Mexico; follow the Mexico-Texas coastline (circum-Gulf migrants); or cross the Gulf of Mexico between Mexico's Yucatan Peninsula and the Texas Coast (trans-Gulf migrants) (TPWD 2011). Major migratory flyways are shown in Figure 3-6. The largest concentration of northbound migrating birds crosses the Gulf of Mexico reaching the northern Gulf of Mexico shoreline between the northern Texas coast and the Florida Panhandle (Morrison 2006).

Many of the bird species considered to be of conservation concern are also listed in wildlife action plans developed by the five states along the northern Gulf Coast. Species are listed as Species of Greatest Conservation Need (SGCN) due to limited distributions and are restricted by requirements for habitat, nesting, or diet. Additional discussion of bird ecology is found in Appendix A.6. There are a variety of stressors that impact birds in the Gulf of Mexico including human actions related to development, agriculture, or forestry and natural factors such as disease. Stressors may affect key ecological requirements such as habitat quality and availability, foraging quality and opportunities, and breeding success. All migratory birds are protected under the Migratory Bird Treaty Act (MBTA) of 1918 (16 U.S.C. 703–712).

Description and Ecological Importance

This section presents an overview of the significance of the northern Gulf Coast to some groups of birds and the bird species found within the region, particularly those present within the habitats along the northern Gulf Coast and pertinent to Early Restoration.

Waterfowl

Waterfowl include swans, geese, and ducks that migrate from summer nesting areas in the northern U.S. and Canada along flyways to wintering grounds along the northern Gulf Coast, as well as resident waterfowl species that breed and inhabit the Gulf region year round (e.g., mottled duck and whistling-ducks).

The coastal marshes of Louisiana, Mississippi, and Alabama provide winter habitat for more than half of the wintering duck population using the Mississippi Flyway while the coastal wetlands of Texas provide wintering habitat for more than half of the Central Flyway waterfowl population (Esslinger and Wilson 2002). As a result, the northern Gulf Coast provides wintering habitat for large continental populations of several waterfowl species including: 95% of gadwall, 80% of green-winged teal, 80% of redhead, 60% of lesser scaup, and 25% of northern pintail. In addition, the northern Gulf Coast provides year-round habitat for 90% of the mottled duck population in North America and is a key breeding area for whistling-ducks (Esslinger and Wilson 2002).

Pelagic Seabirds

Pelagic bird species (seabirds) live most of their lives in open marine waters, roosting and feeding at the water surface the entire year. In the breeding season, mature adults return briefly to nesting areas on islands or along coastlines. Nesting of pelagic species in the Gulf of Mexico region is very limited and includes only a few locations containing tern colonies. Seabirds regularly observed within the Gulf of Mexico include petrels, shearwaters, storm-petrels, tropicbirds, frigatebirds, boobies, gannets, phalaropes, gulls, terns, skuas, and jaegers (Ribic et al. 1997; McKinney 2009; Peake and Elwonger 1996). Some gull and tern species are also considered pelagic species; however, as colonial nesting species they are discussed separately below.

Colonial Waterbirds

Colonial waterbirds nest in social nesting groups (colonies) often containing a mix of species of a similar group (e.g., a wading bird colony may include multiple species of herons and egrets). This guild consists of two principal groups: wading birds (e.g., herons, egrets, ibises) and ground- or beach- nesting species (e.g. terns and gulls). Ground-nesting species can be further divided into species that feed in pelagic (open water) habitats such as cormorants, gulls, and terns and shorebirds that usually feed in open shoreline habitats. Shorebirds are described below. All three groups feed mostly on aquatic organisms, and as a result, nesting colonies are usually concentrated within appropriate coastal habitats. The location and size of nesting colonies depend directly on the presence of predators, suitable nesting habitat and adequate food availability (Duke and Kruczynski 1992).

Colonies of wading birds may also be referred to as “rookeries” or “heronries.” Wading birds are those birds with long legs, long necks, and long bills that allow them to forage in shallow water, probing or actively capturing fish, frogs, aquatic insects, crustaceans, and other prey (Terres 1991). Wading bird families found along the Gulf Coast include herons and egrets, storks, ibises and spoonbills, and cranes. Typical wading bird species include great blue heron, great egret, snowy egret, little blue heron, and tricolored heron. Reddish egret and roseate spoonbill are two species within the U.S. restricted in range to habitats in the Gulf Coast. Colonial-nesting species that feed in open water include cormorants, gulls, terns, and pelicans. These species actively pursue prey (generally fish) by plucking them from the surface or diving underwater to capture fish.

Shorebirds

Shorebirds are generally restricted to coastline and inland water margins (e.g. beaches, mudflats, shallow wetlands). The Gulf Coast contains some of the most important shorebird habitat in North America. Many of these species stop to rest and forage during migration flights or spend the winter in nearshore habitat along the Gulf Coast. For migrating and wintering shorebirds traveling to central and South America, the wetlands and barrier islands of this region provide critical food resources necessary to survive their migration to and from their wintering grounds in South America (Withers 2002). According to the *U.S. Shorebird Conservation Plan* (Gulf Coastal Prairie Working Group 2000) for the Lower Mississippi/Western Gulf Coast Shorebird Planning Region, the Gulf Coast provides breeding, wintering, and migratory habitat for 39 species of shorebirds, and the Gulf Coast is considered to be of extremely high importance to 14 species and of considerable importance to 21 species.

The northern Gulf Coast provides habitat for colonial ground- or beach-nesting shorebird species that breed on beaches, flats, dunes, bars, barrier islands, and similar nearshore habitats. Shorebirds that breed along the Gulf Coast include plovers, oystercatchers, willets, avocets, and stilts.

Marsh-Dwelling Birds

"Marsh-Dwelling bird" is a general term for birds that live in or around marshes and swamps. Along the Gulf Coast, bird species found in salt and freshwater marshes include grebes, bitterns, rails, gallinules, limpkin, and passerines exemplified by marsh wren, sedge wren, and several *Ammodramus* sparrow species. Some are year-round residents, but most marsh birds in this region are northern breeders that winter in Gulf Coast marshes. Some of these species (Black rail, Yellow Rail, Sedge Wren, Nelson's Sparrow) have a large percent of their population that is dependent on the marsh habitat in the Gulf region for overwintering.

Passerines

Passerines (e.g., flycatchers, vireos, crows, swallows, chickadees, nuthatches, wrens, thrushes, warblers, sparrows, tanagers, grosbeaks, blackbirds, and finches) and near passerines (e.g., pigeons, doves, cuckoos, nightjars, swifts, hummingbirds, kingfishers, and woodpeckers) encompass the majority of land bird species. Many species are neotropical migrants that use a variety of nesting habitats in North America and winter in the Caribbean and Central and South America. As with shorebirds, the northern Gulf Coast is an important stopover for migrating passerines and near passerines providing resting and foraging habitat.

Raptors

Raptors that occur along the northern Gulf Coast include vultures, osprey, owls, kites, hawks, harriers, caracaras, eagles, and falcons. Raptors may be found as year-round residents, migrants, and wintering species. As a group, raptors prey on other birds, mammals, reptiles, amphibians, fish, carrion, and many invertebrates. Some species feed on a variety of prey items (red-tailed hawk) while other species such as Cooper's hawk have a narrow range of prey (Sibley 2001). Vultures and crested caracara are primarily scavengers. Many species of raptors construct nests of vegetation off the ground in trees; however, several species construct nests on bluffs, cliffs, or man-made structures, use nests of other species, or nest in cavities (Sibley 2001).

Distribution

The range of habitats along the Gulf Coast within each bordering state promotes bird diversity. Many species of birds spend all or a portion of their life cycle along the Gulf Coast using a variety of habitats at different stages. For example, gull and tern species nest onshore but feed offshore where food is abundant, returning with food for their young, and neotropical migrant passerines nest in wetlands, forests, and prairies of northern states and Canada, stopping to rest and forage along the Gulf Coast during spring and fall migrations. Waterfowl that spend the breeding season in wetlands and prairie potholes of the Great Plains, and shorebirds that breed inside the Arctic Circle, may spend the winter along the Gulf Coast. Additionally, many bird species remain year-round using Gulf Coast habitats to nest and raise young.

Threatened and Endangered Bird Species

Species of birds that inhabit or frequent the northern Gulf of Mexico that are protected under the ESA as endangered or threatened species are listed in Table 3-5. Attwater's Prairie-Chicken, Wood Stork, Audubon's Crested Caracara, Everglade Snail Kite, Northern Aplomado Falcon, Mississippi Sandhill Crane, Roseate Tern, Whooping Crane, Piping Plover, Florida Scrub Jay, Florida Grasshopper Sparrow, Cape Sable Seaside Sparrow, and red-cockaded woodpecker. Red Knot has been proposed as a threatened species and Sprague's Pipit is a candidate for listing. The endangered Northern Aplomado Falcon is being re-introduced to the coastal savannahs along the Gulf of Mexico on the Coastal Bend and Lower Coast of Texas as well as in west Texas.

Federal and State agencies are defining and outlining bird conservation plans and initiatives using an integrative and regional approach primarily based on the lists of *Birds of Conservation Concern 2008* (USFWS 2008). These lists present species, subspecies, and populations of all migratory nongame birds that without conservation actions, could become candidates for listing under the ESA (USFWS 2008). The goals of these lists are to conserve avian diversity and to prevent or remove the need for additional ESA listings by implementing conservation and management actions (USFWS 2008). Yellow rail, Black Rail, Nelson's sparrow, and the seaside sparrow species complex are all marsh-dwelling bird species that are USFWS Bird Species of Conservation Concern and considered as Species of Greatest Conservation Need in Gulf States. The white-tailed kite, red-shouldered hawk, and crested caracara are also USFWS Birds of Conservation Concern.

Table 3-5. Threatened and endangered birds of the Gulf of Mexico.

COMMON NAME	FEDERAL STATUS	USE OF GULF
Attwater's Prairie-Chicken	Endangered	Coastal prairie with tall and short grasses. Known to occur in seven counties in Texas.
Audubon's Crested Caracara	Threatened	Within the northern Gulf of Mexico, it occurs in the southern half of Peninsular Florida in dry or wet prairie, scrub, and improved or semi-improved pasture.
Northern Aplomado Falcon	Endangered	This species breeds from Cameron to Calhoun County in the extreme southern portion of the Texas Gulf Coast; birds outside of this area are rare.
Everglade Snail Kite	Endangered	This species is a year-round resident in a small area of the extreme southern portion of the Florida Gulf Coast.
Mississippi Sandhill Crane	Endangered	A portion of this species is present year-round in Mississippi, but most birds use areas across the entire Gulf Coast primarily as a winter habitat.
Piping Plover	Endangered	The winter range for this species includes all five Gulf states.
Red Knot	Proposed Threatened	This species winters along the Gulf coast of all five states.
Sprague's Pipit	Candidate	Winters in coastal counties of Texas and Louisiana and other non-coastal locations. Habitat consists of well-drained open grasslands and fields.
Roseate Tern	Threatened	This species has breeding grounds in the Florida Keys.
Whooping Crane	Endangered	The only self-sustaining natural, wild population of this species winters at the Aransas National Wildlife Refuge along the Texas Gulf Coast.

COMMON NAME	FEDERAL STATUS	USE OF GULF
Wood Stork	Endangered	A portion of this species is present year-round along the Florida Gulf Coast. The entire population disperses to areas throughout the Gulf Coast post-breeding.
Florida Scrub Jay	Threatened	Peninsular Florida. Scrub and scrubby flatwoods habitats of Florida.
Florida Grasshopper Sparrow	Threatened	Peninsular Florida in dry prairie that is relatively open and low in stature.
Cape Sable Seaside Sparrow	Endangered	Habitat within Everglades National Park, Big Cypress National Preserve, and the Southern Glades Wildlife and Environmental Area of south Florida.
Red-cockaded woodpecker	Endangered	Occurs in all five Gulf states in mature pine forests, specifically those with longleaf pines averaging 80-120 years old and loblolly pines averaging 70-100 years old.

3.3.2.9 Terrestrial Wildlife

A wide variety of terrestrial wildlife species are found in the northern Gulf Coast region, including invertebrates, amphibians, reptiles, and mammals. This section includes descriptions of a few species that are found in terrestrial habitats in the northern Gulf of Mexico. These examples include diamondback terrapin, beach mice, American alligator, otter, and mink that live in coastal, riparian and upland areas. Additional listed terrestrial wildlife species are described in Appendix A.7.

Description and Ecological Importance

Diamondback terrapins are believed to be the only turtle in the world that lives exclusively in brackish water habitats (e.g., tidal marshes, estuaries, and lagoons) (Griffin et al. n.d.). This species primarily forages on fish, invertebrates (e.g., snails, worms, clams, crabs), and marsh grass. Nesting for the species occurs within sandy beach and/or shell habitats. The Diamond-backed terrapin is not listed as "threatened" or "endangered" by the USFWS (2013); however, along the Gulf Coast their State Conservation Status ranges from S4 (apparently secure) in Florida to S3 (vulnerable) in Texas, to S2 (imperiled) in Alabama, Mississippi, and Louisiana, where a number of conservation programs including re-introduction efforts are currently underway (NatureServe 2013). Currently, threats to the diamondback terrapin include incidental drowning in crab traps, coastal development, pollution, drainage and impoundment of salt marshes, human disturbance of nesting sites, and changes in fresh water flow into estuarine systems (Seigeland Gibbons 1995; Dorcas et al. 2007).

There are five species of beach mice in the northern Gulf of Mexico: Alabama, Perdido Key, Santa Rosa, Choctawhatchee, and St. Andrew. Beach mice in general exhibit typical nocturnal behavior (Wolf and Esher 1978 as cited in USFWS n.d.a). Beach mice appear to inhabit a single home range during their lifetime (Blair 1951 as cited in USFWS n.d.a) and the sizes of home ranges vary among species/subspecies. The primary and secondary dunes (frontal dunes) are considered optimal beach mouse habitat since it is where the mice were thought to reach their highest densities (Blair 1951, Meyers 1983, and Holler 1992 as cited in USFWS n.d.a). The scrub dunes appear to serve as refugia for beach mice during and after a tropical cyclone event (Holliman 1983 and Swilling et al. 1998 as cited in USFWS n.d.a).

Although they have a limited range, beach mice play an important role in the northern Gulf ecosystem. They consume plant material (e.g. seeds from sea oats, coastal panic grass, sea rocket, and other primary dune species) and invertebrates and serve as prey for predators, such as carnivorous mammals, snakes, and birds of prey (Borden 2005). In addition, beach mice help plant communities by dispersing seeds (Borden 2005).

Main stressors that negatively impact beach mice include severe storms that destroy habitat and drown mice in their burrows, coastal development and loss of dunes, and predators (e.g., domestic cats and red fox) (Borden 2005). The present-day distribution of beach mice is greatly reduced due to habitat loss and fragmentation associated with residential and commercial real estate development. This fragmenting isolates the remaining populations and substantially increases their vulnerability to the effects of tropical storms, weather cycles, predation, and other environmental factors (Holliman 1983 as cited in ADCNR 2011a).

American alligators are an important part of the environment; not only do they control populations of prey species, they also create peat and "alligator holes," and in this process create habitat that is invaluable to other species (Britton 1999 as cited in Schechter and Street 2000). These animals are carnivores with a diverse diet including fish, snails, birds, frogs, turtles, and mammals near the water's edge (Pajerski et al. 2000).

North American river otters feed on fish, frogs, crayfish, mollusks, and small mammals (Smithsonian National Zoological Park n.d.). River otters are ecologically significant due to their importance in the food-web where they help to control prey populations (Capital Regional District 2012).

American mink are also important due to their role in the freshwater food chain. They are found in water habitats mostly associated with coniferous and mixed forest. Grasslands are also suitable habitat if open water or marshland is present nearby (Sullivan 1996). The American mink is a carnivore, feeding on fish, crayfish, waterfowl, and small mammals.

Stressors affecting terrestrial wildlife in the northern Gulf of Mexico include habitat loss and degradation, pollution, invasive species, and climate change. Terrestrial invasive plant species can alter habitat for wildlife by out-competing native species and reducing suitable habitat. Terrestrial invasive animal species range from invertebrates (e.g., invasive red fire ants) to mammals (e.g., feral hogs) and can prey upon and compete with other wildlife species and alter habitat through their foraging techniques and other behaviors (e.g., rooting of feral hogs).

Distribution

Terrestrial wildlife species are distributed throughout the northern Gulf Coast region. Briefly, this section reviews the distribution of the highlighted species described above. Diamondback terrapins are found along the Atlantic Coast of the eastern U.S. from Cape Cod to the Florida Keys, and west along the northern Gulf Coast to Texas (Griffin et al. n.d.). Beach mice are found in Florida and Alabama. The Alabama beach mouse lives along the coast of Baldwin County, Alabama; the Perdido Key beach mouse lives on Perdido Key in Baldwin County, Alabama and Escambia County, Florida; the Santa Rosa beach mouse lives on Santa Rosa Island, Escambia County, Florida; the Choctawhatchee beach mouse lives in Walton and Bay Counties, Florida; and the St. Andrew beach mouse lives in Bay and Gulf Counties,

Florida. American alligators are found within the great river swamps, lakes, bayous, marshes, and other bodies of water along the northern Gulf and Lower Atlantic Coastal Plains (Conant and Collins 1991). American mink range throughout the Gulf Coast region. They prefer small streambanks, lakeshores, and marshes and favor forested wetlands with abundant cover such as shrub thickets, fallen trees, and rocks (DeGraaf and Yamasaki 1986). The North American river otter can be found throughout the Gulf Coast region with the exception of the southwest Texas coast (Smithsonian National Museum of Natural History n.d.).

Threatened and Endangered Terrestrial Species

Beach mice of Florida and Alabama are listed as endangered on the U.S. Endangered Species List, except the Santa Rosa beach mouse which is not protected by the ESA. Threats to all beach mouse subspecies include: habitat loss, fragmentation, and degradation from coastal development, hurricane activity, and climate change; loss of genetic diversity; and risk of predation. Critical habitat is designated for Alabama, Perdido Key, Choctawhatchee, and St. Andrew beach mice. Primary constituent elements (PCE) of critical habitat are: 1) A contiguous mosaic of primary, secondary scrub vegetation, and dune structure, with a balanced level of competition and predation and few or no competitive or predaceous nonnative species present, that collectively provide foraging opportunities, cover, and burrow sites; 2) Primary and secondary dunes, generally dominated by sea oats that, despite occasional temporary impacts and reconfiguration from tropical storms and hurricanes, provide abundant food resources, burrow sites, and protection from predators; 3) Scrub dunes, generally dominated by scrub oaks, that provide food resources and burrow sites, and provide elevated refugia during and after intense flooding due to rainfall and/or hurricane induced storm surge; 4) Functional, unobstructed habitat connections that facilitate genetic exchange, dispersal, natural exploratory movements, and recolonization of locally extirpated areas; and 5) A natural light regime within the coastal dune ecosystem, compatible with the nocturnal activity of beach mice, necessary for normal behavior, growth and viability of all life stages. Information on the threatened and endangered status of terrestrial species not discussed above can be found in Appendix A.7.

3.4 Human Uses and Socioeconomics

The human environment, as defined by the Council on Environmental Quality (CEQ) describes the relationship between people and the environment (40 C.F.R. § 1508.14). Socioeconomics is an umbrella term used to describe the interactions between social systems and the economy. The economic structure of a location affects the livelihoods of the people who live there, impacting their communities and their sense of place. Only basic information about the social and economic make-up of the Gulf Coast region is described in this document because socio-economic interactions can be difficult to describe and predict at the programmatic level; further socio-economic information is provided at the project-specific level (Chapters 8-12).

Millions of people live, work, and recreate in the northern Gulf of Mexico region, and therefore, rely on the natural and physical resources the Gulf's environment provides. In 2009, the total economy of the Gulf of Mexico region supported over 22 million jobs (17.2% of all jobs in the U.S.), and produced over $2 trillion in GDP (16.7% of all GDP produced in the U.S.). In the same year, six ocean-dependent sectors of the regional economy (living marine resources, marine construction, marine transportation, offshore mineral extraction, ship and boat building, and marine-related tourism and recreation) accounted for

480,000 jobs (2.2% of all jobs in the region) and produced about $100 billion in GDP (4.3% of total regional GDP) (NOAA 2012g).

Land use in the region comprises a heterogeneous mix of industrial activities: manufacturing, marine, shipping, agricultural, and petrochemical industry activities; recreation; and tourism. Along the northern Gulf Coast there are numerous state-managed, protected areas and recreational sites (such as State Parks and beaches) as well as units of both the National Park Service (NPS) and the USFWS.

This section briefly provides an overview of the socioeconomic conditions in the region, including cultural and aesthetic resources, infrastructure, and the land and marine management activities that are pertinent to Early Restoration. In addition, it describes aesthetic and visual resources of the northern Gulf Coast region, and generally characterizes public health and safety issues, including flood protection.

Note: As with the above discussion of natural resources, and natural resource services, in the northern Gulf of Mexico, the following discussion of human uses and socioeconomics of those resources and services is not intended to be a precise, definitive, or complete survey of those human uses or socioeconomics, nor is citation to a particular source meant to suggest a preference for the information in that sources vis-à-vis other sources of similar information. Rather, the following discussion is intended to give a general sense of the type and scale of those human uses and socioeconomics. The comprehensive NRDA currently under development by the Trustees may provide a more definitive accounting of some or all of those human uses and socioeconomics.

3.4.1 Socioeconomics and Environmental Justice

The demographic description of the region is focused on the counties/parishes that predominate the coastal environment.

The population of the Gulf coastal counties and parishes was nearly 17 million in 2010 according to the U.S. Census. Table 3-6 summarizes 2010 Census data on population size and change in population in the region. Four Gulf of Mexico counties have more than 500,000 residents: Lee, Pinellas and Hillsborough counties, Florida; and Harris County, Texas.

For additional demographic information on race, ethnicity, employment, income, poverty, education, language, and place of birth, see Appendix A.8.

Executive Order 12898 (Feb. 11, 1994) states that, to the greatest extent practicable, federal agencies must “identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations.” To this effect, the Council on Environmental Quality (CEQ) has issued guidance directing federal agencies to analyze the environmental effects, including human health, economic, and social effects, of their proposed actions on minority and low-income communities when required by NEPA (CEQ 1997). CEQ has defined members of minority populations to include: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic. Low income populations for this analysis were determined based on the U.S. Census Bureau 1999 poverty thresholds (U.S. Census Bureau 1999). The analyses in this ERP/EA comply with Executive Order 128898 and CEQ’s guidance.

Table 3-6. Population data for coastal counties in Texas, Louisiana, Mississippi, Alabama, and Florida.

GEOGRAPHIC AREA	TOTAL POPULATION	CHANGE IN POPULATION 2000-2010
Texas Coastal Environment Counties	6,197,133	17.3%
State of Texas	25,145,561	20.6%
Louisiana Coastal Environment Parishes	2,215,459	-1.4%
State of Louisiana	4,533,372	1.4%
Mississippi Coastal Environment Counties	370,702	1.8%
State of Mississippi	2,967,297	4.3%
Alabama Coastal Environment Counties	595,257	10.2%
State of Alabama	4,779,736	7.5%
Florida Coastal Environment Counties	7,434,861	19.0%
State of Florida	18,801,310	17.6%
Coastal Environment Counties and Parishes Total	16,813,412	14.5%
Data Source: U.S. Census Bureau 2010.		

3.4.2 Cultural Resources

People have lived in the coastal region of the Gulf of Mexico for more than 10,000 years. Today many unique and diverse cultures call the Gulf coast home. These cultures, past and present, are often closely linked to the environmental and natural resources that comprise the Gulf Coast ecosystem, and which these projects seek to help restore. Cultural resources encompass a range of traditional, archeological, and built assets. Historic properties in the affected coastal communities date from both the prehistoric and historic periods.

The National Historic Preservation Act of 1966 (NHPA), as amended in 2000 (NHPA; 16 U.S.C. § 470(w)), defines a historic property as "any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion on the National Register [of Historic Places]." Historic properties encompass built resources (bridges, buildings, piers, etc.), landscapes, archeological sites, and traditional cultural properties (TCPs). TCPs are historic properties significant for their association with practices or beliefs of a living community that are both fundamental to that community's history and part of the community's cultural identity. These properties may be above ground, below grade, or submerged in waterways and include resources listed in, or eligible for listing in, the National Register of Historic Places (NRHP). Terrestrial cultural resources may include buildings, structures, sites, and objects. Cultural resources offshore may include shipwrecks, archeological sites, structures, or districts. Archaeological, architectural, and Native American resources are protected by a variety of laws and their implementing regulations.[8]

[8] Federally, these include the NHPA as amended in 2000; the Archeological and Historic Preservation Act of 1974; the Archaeological Resources Protection Act of 1979; the American Indian Religious Freedom Act of 1978; the Native American Graves Protection and Repatriation Act of 1990; the Submerged Lands Act of 1953; the Abandoned Shipwreck Act of 1987; and the Sunken Military Craft Act. The Advisory Council on Historic Preservation (ACHP) further guides treatment of archaeological and architectural resources through the regulations, Protection of Historic Properties (36 C.F.R. § 800). Additional regulations and guidelines for shipwrecks include 10 USC 113, Title XIV for the Sunken Military Craft Act; the Abandoned Shipwreck Guidelines prepared by the NPS (NPS 2007); and the Guidelines for Archaeological Research Permit Applications on Ship and Aircraft Wrecks under the Jurisdiction of the Department of the Navy.

Although TCPs are typically associated with Native American culture, such historic properties also may be associated with other ethnic groups or communities. TCPs may vary between rural and urban areas and even within the same ethnic group. Research and contact with appropriate groups is part of the identification of TCPs.

The NRHP is the official Federal list of historic properties and is maintained by the NPS. As of November 2011, more than 10% of the properties listed in the NRHP were located in the affected Gulf States (9,083 of the 86,255 properties). The NRHP is dynamic; the list is not comprehensive and does not include all properties that meet the criteria for significance and integrity. Listings are limited only to those historic properties that have been formally documented, nominated, and accepted for inclusion by the Keeper of the NRHP.[9]

3.4.3 Infrastructure

Components of physical infrastructure and public services include Federal, State, Tribal, parish, municipal, and/or private facilities that support development and protect public health and safety. The amount and placement of infrastructure and public service development depend heavily on population and migration patterns, and employment trends. The massive, regional transportation infrastructure comprises road and highway networks, mass transit systems, railways, canals, seaports, airports, and ferries, as well as bike and pedestrian paths. In the coastal environment, there are about 1,800 miles of interstate highways, more than 7,000 miles of major U.S. and state highways, and almost 6,000 miles of rail lines. In addition, the Energy Independence and Security Act of 2007 authorized "American's Marine Highway Program," making the nation's waterways part of the surface transportation system. Flood control, water management, and navigational infrastructure are discussed under Section 3.4.11.

3.4.4 Land and Marine Management

Land and marine areas may be set aside for a variety of active and passive recreational purposes. Land may be managed for wildlife and habitat protection and conservation, and/or scenic, cultural, and historical values. Land management may be at the Federal, State, or local levels by private organizations. Figure 3-12 provides a map of public lands in the Gulf of Mexico Coastal States. The following sections describe land and marine management programs in more detail.

For marine management, the 1982 United Nations Convention on the Law of the Sea (UNCLOS) established the sovereign rights of coastal states beyond their land territory and internal waters, described as a territorial sea. The U.S. is not a party to the UNCLOS, but recognizes the treaty as customary international law. For regulatory purposes, State waters extend from the baseline to three nautical miles in Louisiana, Mississippi, and Alabama. In Texas and on the Gulf Coast of Florida, State waters extend to 9 nautical miles. Federal waters continue from the state seaward boundary to 200 nautical miles from the baseline (the limits of the Exclusive Economic Zone or EEZ) (Figure 3-12).[10] Marine areas are managed by different Federal, State, or private agencies for a range of different purposes including managing for marine mineral resources, protecting natural resources, and managing

[9] The NRHP includes historic properties that possess significance and integrity applying the National Register Criteria for Evaluation (36 C.F.R. § 60(a-d)).

[10] Application of the Oil Pollution Act can extend beyond 200 nautical miles if impacts exist seaward of that boundary.

for recreational purposes. Marine Protected Areas (MPAs) are established and managed by all levels of government and include marine sanctuaries, estuarine research reserves, ocean parks, and marine wildlife refuges. MPAs may be established to protect ecosystems, preserve cultural resources such as shipwrecks and archaeological sites, or sustain fisheries production.

3.4.4.1 National and State Parks

This section includes a summary of State and National Parks, natural areas, recreational areas, and historical/cultural landmarks located along the northern Gulf of Mexico. Parks can be set aside as recreational, natural, or historical and cultural areas. Recreational areas provide leisure activities for visitors, including picnic areas, hiking, camping, biking, and water sports. Natural areas are minimally human influenced areas that are set aside to maintain the natural scenic, geologic, or ecological value of the area. Historical and cultural areas are set aside to preserve those values.

National Parks

The NPS preserves the unimpaired natural and cultural resources and values within the national park system for the enjoyment, education, and inspiration of this and future generations. In the northern Gulf Coast, these areas include Palo Alto Battlefield National Historical Park (Texas), Padre Island National Seashore (Texas), Jean Lafitte National Historic Park and Preserve (Louisiana), New Orleans Jazz National Historical Park (Louisiana), Gulf Islands National Seashore (Mississippi and Florida), DeSoto National Memorial (Florida), Big Cypress National Preserve (Florida), Everglades National Park (Florida), and Dry Tortugas National Park (Florida). Five of these parks are also recognized as MPAs: Padre Island National Seashore, Jean Lafitte National Historical Park and Preserve, Gulf Island National Seashore, Dry Tortugas National Park, and Everglades National Park.

State Parks

State parks include recreational areas, historic and cultural sites, and natural areas along the coasts of the five Gulf States.

The Texas Parks and Wildlife Department manages 106 sites throughout Texas, of which 78 are state parks, 19 are state historic sites, and 7 are natural areas. Total land cover of the parks spans over 600,000 acres. Of the historic sites, four are located along the Gulf Coast: Battleship *Texas*, Lipantitlan, Port Isabel Lighthouse, and San Jacinto Battleground. The Texas state parks along the Gulf Coast include, but are not limited to, Brazos Bend, Galveston Island, Goose Island, Lake Corpus Christi, Lake Texana, Mustang Island, Sea Rim, Sheldon Lake, Resca de la Palma, Estero Llano Grande, Bentsen-Rio Grande Valley, Port Isabel, and San Jacinto Monument. Galveston Island and Mustang Island are two of the most popular state parks along the Gulf Coast (TPWD n.d.a). The state parks provide outdoor recreation opportunities like hunting, fishing, swimming, camping, hiking, biking, and bird watching.

Louisiana's State Parks, Historic Sites, and Preservation Areas have been chosen for their scenery and historical, cultural, architectural, and/or archeological significance. The state manages 22 State Parks, 18 Historic Sites (State Commemorative Areas), and 1 Preservation Area. State parks along the Gulf Coast of Louisiana include Sam Houston Jones, Palmetto Island, Cypremort Point, Lake Fausse Pointe, Grand Isle, Bayou Segnette, St. Bernard, Tickfaw, Fairview-Riverside, and Fontainebleau. Fort Pike is one of the state's historic sites. Louisiana State Parks offer recreational opportunities for boating, camping, fishing,

hiking, history and nature programs, and swimming. The State Parks are managed by the Louisiana Department of Culture, Recreation, and Tourism (LDCRT) (LDCRT 2011).

Mississippi's Department of Wildlife, Fish, and Parks, Parks Division, manages 25 state parks. There are two state parks located along the Gulf Coast of Mississippi, Shepard State Park and Buccaneer State Park. Buccaneer State Park provides recreational access to hiking trails, ocean fishing, beachcombing, bird watching, swimming, windsurfing, bike riding, and golfing. Buccaneer State Park was directly hit by Hurricane Katrina in 2005; however, the park was rebuilt with more than 275 campsites. Shepard State Park is a 395-acre park in Gautier, Mississippi. This park provides visitors with abundant trees, wildflowers, bike and nature trails, a disc golf course, and 28 campsites (Mississippi State Parks n.d.). Mississippi Department of Marine Resources manages approximately 30,000 acres of coastal preserve that are open for recreation. These areas are crucial coastal wetland habitat and are preserved in 20 different sites across the state.

The Alabama Department of Conservation and Natural Resources, State Parks Division, manages Alabama's State Parks. Alabama contains 22 state parks spanning over 38,000 acres. Alabama State Parks offer fishing, boating, swimming, camping, hiking, golfing, nature crafts, and horseback riding. There are two parks located along the Gulf Coast of Alabama, Gulf State Park and Meaher State Park. Gulf State Park is 6,150 acres along the coast of Alabama with 2 miles of beaches. The park provides a variety of amenities including campgrounds, a pool, a nature center, a fishing pier, a pavilion, cabins, cottages, and a golf course. Gulf State Park also originally contained a lodge and conference center, which were destroyed in 2004 by Hurricane Ivan. Meaher State Park is a 1,327 acre park located in the wetlands along Mobile Bay (ADCNR 2011c). Other public lands in the coastal area of Alabama include Alabama Forever Wild Land Trust areas (including the Grand Bay), Mobile-Tensaw River Delta, Perdido River and Weeks Bay tracts, as well as a number of small state-owned islands.

The Florida Park Service manages 161 parks spanning 700,000 acres and 100 miles of sandy beaches. The Park Service also manages over 40,000 historic artifacts, 300 historic structures, and more than 1,800 archeological sites. There are 60 Florida State Parks along the Gulf Coast of Florida offering year-round outdoor activities from swimming and diving to birding and fishing or hiking. The goal of Florida State Parks is to provide visitors with a selection of diverse natural and cultural sites (FDEP 2011). Nearly all State parks listed as MPAs in the Gulf of Mexico are located in Florida waters. The largest State park listed as an MPA in the Gulf of Mexico is Anclote Key State Park, located 3 miles off Tarpon Springs, Florida. This park was established in 1960 focusing on conservation of natural heritage and sustainable production in the 18.5-square-mile area (NMPAC 2011b). The State park is made up of four islands, Anclote Key, North Anclote Bar, South Anclote Bar, and Three Rooker Island (Florida State Parks n.d.). Florida State Parks are administered by the Florida Department of Environmental Protection (FDEP). Additionally, FDEP's Florida Coastal Office oversees the State's 41 aquatic preserves, a unique system encompassing almost 2.2 million acres of recreationally and aesthetically important submerged lands, as well as some associated uplands.

3.4.4.2 Refuges and Wildlife Management Areas

National Wildlife Refuges (NWRs) and State Wildlife Management Areas (WMAs) located in the northern Gulf of Mexico provide habitat for marine and terrestrial wildlife. NWRs, managed by the USFWS, are lands and waters preserved for conservation, management, and restoration of fish, wildlife, and plant

resources. State WMAs are wildlife lands managed by State agencies and set apart for recreational activities such as hiking, fishing, hunting, wildlife viewing, and other outdoor activities. In some states, WMAs may also be established to perform research on wildlife populations and habitats, and conduct education on sound resource management in addition to providing recreation opportunities.

National Wildlife Refuges

There are more than 40 NWRs located along the coastline or within the coastal environment of the northern Gulf of Mexico from Texas through Florida (Figure 3-13). Most refuges along the Gulf Coastline were established to provide wintering areas for ducks, geese, shorebirds, and other migratory birds and to provide habitat for other wildlife in general. Three associated NWRs in Mississippi and Alabama make up the Gulf Coast National Wildlife Refuge Complex. Twenty-three NWRs are also designated as MPAs. NWR MPAs protect endangered species, contain resting areas for migrating birds, provide suitable nesting habitats, and contain spawning sites for fish and shellfish species.

State Wildlife Management Areas

There are more than 130 state WMAs managed by Texas, Louisiana, Mississippi, Alabama, and Florida. State WMAs are rural landscapes set aside for wildlife and provide recreational opportunities that include hunting, hiking, and bird watching.

3.4.1.1 Land Trusts

A land trust is a local, regional, or national nonprofit organization that, as all or part of its mission, actively works to conserve land by undertaking or assisting in land or conservation easement acquisition, or by its stewardship of such land or easements. Land trusts have varying conservation objectives; some work in specific geographic areas or concentrate on protecting different natural, scenic, or cultural features. Most land trusts in the northern Gulf Coast region are focused on conservation of critical, natural habitat; some land trusts also promote educational and recreational opportunities. Land trusts can acquire land through purchase, donation, or by other means, and in some cases they subsequently transfer that land to a public agency. They can also protect land through other methods such as negotiating and preparing for acquisition by other organizations or agencies. A land trust can also protect land by accepting conservation easements and ensuring that the easement is effectively monitored.

3.4.4.3 Marine Protected Areas

According to Executive Order 13158, an MPA is defined as “any area of the marine environment that has been reserved by Federal, State, territorial, tribal, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein.”

Most MPAs have a primary focus on conservation of natural heritage, while a few have a primary focus on sustainable production or cultural heritage (NMPAC 2010). Natural heritage MPAs are managed to conserve, restore, and understand the area’s natural biodiversity, populations, communities, habitats, and ecosystem. A sustainable MPA supports the continued extraction of renewable, living resources but protects the area’s habitat for feeding, spawning, mating, or nursery grounds. Cultural heritage MPAs are managed to protect, understand, and maintain the legacy of physical evidence and attributes of a group or society for future generations (NMPAC 2011a).

At present, there are approximately 295 MPAs, managed under different jurisdictions and regulations, located within the northern Gulf of Mexico region. These MPAs cover nearly 40% of the Gulf of Mexico U.S. marine waters (Figure 3-13). Roughly 77% of the Gulf of Mexico MPAs is managed by State governments, but the majority of the area within MPAs in the Gulf of Mexico is managed by Federal agencies. Table 3-7 lists the number of MPAs under Federal or Gulf State jurisdiction and the percent of MPA area by jurisdiction (NOAA 2012h). These MPAs are mostly controlled for fishery management by NMFS and the GMFMC (NMPAC 2011b). The MPAs in the Gulf of Mexico include areas located within the Gulf States, the National Estuarine Research Reserve (NERR) System, the NWR System, and two National Marine Sanctuaries. De facto Marine Protected Areas (DFMPAs) are marine areas that are established for reasons other than conservation, such as economic use, human health or safety, and protection of government or private property. The U.S. Coast Guard (USCG), U.S. Army, and U.S. Navy manage DFMPAs. Examples of DFMPAs include safety, security, and danger zones, restricted areas, prohibited lighting areas, some anchorage grounds, and traffic separation schemes (NOAA 2011d).

Table 3-7. Marine Protected Areas of the Gulf of Mexico.

	TEXAS	LOUISIANA	MISSISSIPPI	ALABAMA	FLORIDA	FEDERAL
Number of MPAs	19	17	21	7	217	33
Percent of Area (%)	<1	1	1	<1	4	95
Source: NOAA 2012h						

National Estuarine Research Reserve System

The NERR System is a network of 28 areas representing different biogeographic regions of the U.S. that are protected for long-term research, water quality monitoring, education, and coastal stewardship. Established by the Coastal Zone Management Act of 1972, as amended, the reserve system is a partnership program between NOAA and the coastal states. NOAA provides funding, national guidance, and technical assistance. Each reserve is managed on a daily basis by a lead State agency or university, with input from local partners. Reserve staff work with local communities and regional groups to address natural resource management issues, such as nonpoint-source pollution, habitat restoration, and invasive species. Through integrated research and education, the reserves help communities develop strategies to deal successfully with coastal resource issues. Reserves provide long-term water quality monitoring as well as opportunities for both scientists and students to conduct research in a "living laboratory." Several NERRs are located in the northern Gulf of Mexico, including Mission-Aransas, Texas; Grand Bay, Mississippi; Weeks Bay, Alabama; Apalachicola, Florida; and Rookery Bay, Florida (NOAA 2012i).

National Marine Sanctuaries

The National Marine Sanctuaries were developed under the National Marine Sanctuaries Act (NMSA) as areas designated to protect areas of the marine environment with special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archeological, educational, or aesthetic qualities. National Marine Sanctuaries are areas or systems of marine protected areas developed to conserve, protect, and enhance their biodiversity, ecological integrity, and cultural legacy. The Flower Gardens Banks is the sole National Marine Sanctuary in the northern Gulf of Mexico. Day-to-day management of national marine sanctuaries has been delegated by the Secretary of Commerce to

NOAA's Ocean Service Office of National Marine Sanctuaries (NOAA 2013b). A map of marine sanctuaries is presented in Figure 3-13.

3.4.5 Tourism and Recreational Use

Many tourism and recreational opportunities are centered on or around the northern Gulf of Mexico, and are therefore dependent on a clean, healthy Gulf ecosystem. Outdoor recreation, broadly defined, is any leisure time activity conducted outdoors for pleasure or sport, including activities from wilderness camping to watching outdoor performances. This section describes examples of recreational pursuits in the region, including onshore and offshore wildlife observation, hunting, beach and other waterfront use, boating, and recreational fishing.

3.4.5.1 Wildlife Observation

The northern Gulf of Mexico region includes a diverse array of species and ecosystems, providing many opportunities for wildlife observation. The region is an important migratory bird flyway, and an important wintering ground for many avian species. Beaches in the region are nesting grounds for several species of sea turtles, and the waters of the Gulf itself are home to many species of marine mammals. Residents and visitors recreate by observing these species in their natural habitat.

3.4.5.2 Hunting

The USFWS estimates that in 2011, almost 3 million hunting visits were conducted in Gulf Coast states (See Table 3-8). While some hunting typically occurs inland, waterfowl and alligator hunting often occur in coastal areas in the northern Gulf Coast region. Across Gulf States, hunters averaged at least 13 days of hunting in 2006. Hunters utilize all different types of habitats (e.g., wetlands, coastal forests, etc.) around the Gulf. Hunters also rely on healthy populations of the game they are hunting to have successful hunting trips.

Table 3-8. Number of hunting visits in Gulf Coast States in 2011.

STATE	TOTAL NUMBER OF HUNTING VISITS
TEXAS	1,147,000
ALABAMA	535,000
FLORIDA	242,000
MISSISSIPPI	483,000
LOUISIANA	277,000
TOTAL	2,684,000
Source: USFWS, 2011.	

3.4.5.3 Beach and Waterfront Recreation

Visitors to northern Gulf Coast beaches can participate in a range of activities from simply visiting a beach to swimming, snorkeling, wakeboarding, or surfing. Enjoyment of these activities requires clean and healthy shorelines and water resources. Visiting beaches was identified as the most popular recreation activity in the National Survey on Recreation and the Environment, conducted in 2000 (Leeworthy 2001), while participation in swimming, snorkeling, or diving was almost as popular. In addition, water sites other than beaches (e.g., coastal wetlands) also attracted hundreds of thousands of participants in the northern Gulf Coast region.

3.4.5.4 Boating

The northern Gulf coastal environment, with its nearly 2,000 miles of shoreline and 600,000 square miles of open water presents abundant opportunities to sail, motorboat, jet-ski, canoe, and kayak. In 2009, there were a total of 300 marinas in the region.

The online Coastal Travel Guide provides a list of public boat ramps and fishing piers for each coastal county along the Gulf Coast (Coastal Travel Guide 2012) (Table 3-9). Public boat ramps and piers are found throughout the coastal environment.

Table 3-9. Public boat ramps and fishing piers.

GEOGRAPHIC AREA	# PUBLIC RAMPS	# PIERS
Texas Coastal Environment	80	26
Louisiana Coastal Environment	89	3
Mississippi Coastal Environment	47	31
Alabama Coastal Environment	29	6
Florida Coastal Environment	341	96
Total for Coastal Environment	586	162
Source: Coastal Travel Guide 2012. Data are current as of October 2012.		

3.4.5.5 Recreational Fishing

Recreational saltwater fishing in the northern Gulf of Mexico region occurs within estuarine bays, bayous, rivers, nearshore Gulf and offshore Gulf waters. Access to fishing is provided by utilization of fishing piers, offshore platforms, private and public shoreline access, private boats, and charter boats. Common favorite fishing locations include: bridges and highway structures, coastal passes or inlets, along river or stream banks, in mangrove and cypress swamps, on hard-bottom structures including natural or artificial reefs and oyster beds, around aids to navigation, adjacent to wetlands, and within bay and marine waters. Offshore recreational fishing includes the use of charter boats, headboats, and private boats. Offshore anglers pursue reef and other bottom fish and catch and release species.

Catch data indicate that U.S. marine recreational fishing activity (number of fishing trips per year) increased by over 20% in the years from 1996 to 2000, with nearly one third of this growth occurring in the Gulf of Mexico.

More than 30 million fish were harvested by recreational anglers in the Gulf of Mexico in 2009 as reported in the 2011 NOAA Fisheries summary. Key recreational species targeted in the Gulf of Mexico include Atlantic croaker, Gulf kingfish, southern kingfish, sand seatrout, silver seatrout, spotted seatrout, sheepshead porgy, red drum, red snapper, southern flounder, Spanish mackerel, and striped mullet (NOAA Fisheries Service 2011e). Targeted species vary from state to state (Table 3-12). In Texas, Louisiana, and Florida, spotted seatrout was the most commonly harvested species, while in Mississippi and Alabama, sand and silver seatrout were the most commonly harvested fish. Recreational fishers also target oysters, scallops, shrimp and blue crabs in the northern Gulf of Mexico.

3.4.5.6 Tourism

The natural and cultural resources of the Gulf provide a wide range of recreational destinations and tourist attractions that fuel local economies. Outdoor recreationists make millions of trips per year to

the Gulf Coast. NMFS has estimated that, in 2006, the tourist industry contributed 620,000 jobs and more than $9 billion in wages to the Gulf of Mexico region (Gulf-At-A-Glance, GOMA 2008). Economic activity from the tourism and recreation sector is important to the northern Gulf Coast region.

3.4.5.7 Museums, Cultural Resources, and Education Centers

The Gulf Coast region offers access to museums, cultural resources, and education centers, and a great number of these facilities are focused specifically on the Gulf ecosystem itself. These organizations can benefit Gulf Coast residents through their work to protect the environment and the diversity of ecosystems found in and around the Gulf through research and education. They also provide eco-tourism opportunities for visitors to the region.

There are a number of museums and institutes that are tourist destinations unique to the northern Gulf Coast states. These facilities generally combine ecological and nature based education with research and conservation activities. They provide not only unique tourist opportunities but important outreach services as well. These facilities include, but are not limited to, the National Butterfly Center located in Mission, Texas; the World Birding Center in McAllen, Texas as well as its affiliate sites scattered throughout the coastal-Rio Grande Valley area; the Audubon Nature Institute facilities in New Orleans, Louisiana; the Institute for Marine Mammal Studies, INFINITY Science Center at Stennis, Mississippi; Center for Marine Education and Research in Gulfport, Mississippi; Gulf Coast Research Laboratory of the University of Southern Mississippi, Ocean Springs, Mississippi; and the Dauphin Island Sea Lab and Five Rivers Delta Resource Center, Alabama. Area organizations and local governments also offer opportunities for science-based educational outreach experiences for visitors via local nature centers, preserves, and sanctuaries. Organizations offering these opportunities include the Gulf of Mexico Sea Grant Programs, National Audubon Society, The Nature Conservancy, Louisiana Universities Marine Consortium (LUMCON), Conservancy of Southwest Florida, and the Gulf of Mexico Alliance – Environmental Education Network.

The northern Gulf Coast region also hosts a wide range of interesting publicly and privately-owned historical areas that illustrate the area's rich and complex history. These include, but are not limited to, plantation homes, civil war battlegrounds, and structures representing pre- and post-antebellum architecture.

3.4.6 Fisheries

Commercial fisheries represent a multi-billion dollar industry to the northern Gulf Coast region and have traditionally included finfish, shrimp, oysters, and crabs. The following sections include information on the volume and value of fish landed, the number of establishments, employees and payroll, and the economic impacts of the seafood industry and commercial fishing.

3.4.6.1 Commercial Fishing

State, federal, and international agencies regulate fishery resources within their jurisdiction. For species that are not managed by federal regulations, states have the authority to extend state rules into federal waters for residents of that state or vessels landing a catch in that state.

The shrimp, reef fish, and highly migratory species (HMS) fisheries are discussed in more detail below. While these do not encompass all the fisheries or fisheries gear operating in the northern Gulf of Mexico, they are most important to the discussion of potential Early Restoration actions.

The GMFMC is tasked with developing fishery management plans (FMPs) in order to manage fish resources in the Gulf of Mexico from the state territorial waters to the Exclusive Economic Zone (EEZ) (GMFMC n.d.). Several plans are managed jointly with the South Atlantic Fisheries Management Council (SAFMC). There are seven FMPs under the jurisdiction of the GMFMC:

- Migratory Pelagic Management Plan (jointly managed with SAFMC)
- Spiny Lobster Management Plan (jointly managed with SAFMC)
- Reef Fish Management Plan
- Shrimp Fishery Management Plan
- Red Drum Management Plan
- Coral Fishery Management Plan
- Aquaculture Management Plan (implementing regulations are in development)

The FMPs provide detailed information on the biology, distribution, habitat associations, life history characteristics, migratory patterns, spawning characteristics, and nursery areas, and include detailed EFH maps for species they cover. For highly migratory species (HMS), a single EFH figure for the Gulf of Mexico does not exist at this time. Each species has a series of maps based on what is known about various life stages and the geographic area covered by HMS Fishery Management Plan is the entire Atlantic coast of the U.S. and Gulf of Mexico[11].

The shrimp fishery is the dominant fishery in the northern Gulf of Mexico. The estuarine-dependent white, pink, and brown shrimp species, seabobs, and rock shrimp make up the Gulf of Mexico shrimp catch. The fishery in federal waters is managed by NOAA and the GMFMC, who attempt to coordinate management actions with state management programs. The Gulf of Mexico shrimp fishery has been declared overcapitalized and is presently subjected to a moratorium on new permits, which the GMFMC says will assist the economic recovery of the fishery (GMFMC undated, GMFMC undated2, GMFMC 2005).

The GMFMC manages snappers, groupers, tilefishes, jacks, gray triggerfish, and hogfish under the reef fish fishery management plan. Components of the reef fish fishery are managed singly or as separate groups. HMS including tuna, billfish, sharks, and swordfish are managed domestically by the National Marine Fisheries Service under the Magnuson-Stevens Fishery Conservation and Management Act and the Atlantic Tunas Convention Act. Current swordfish regulations for U.S. fishermen include quotas, time area closures, retention limits, size limits, and gear specifications. The *Consolidated Atlantic Highly Migratory Species Fishery Management Plan* covers HMS in the Gulf of Mexico. International management of tuna and tuna-like species is conducted by the International Commission for the Conservation of Atlantic Tunas.

[11] See Chapter 5 of the Final Amendment 1 to the 2006 Consolidated Atlantic Highly Migratory Species Fishery Management Plan, Essential Fish Habitat, June 2009.

Many Gulf States also manage open access fisheries (e.g. Gulf menhaden) via a regional Fishery Management Plan under the auspices of the Gulf States Marine Fisheries Commission (GSMFC). The GSMFC was established by an act of Congress (P.L. 81-66) in 1949 as a compact of the five Gulf States to make recommendations to the governors and legislatures of the five Gulf States regarding the management of the fisheries.

The highest landings by pound of finfish were 1.2 billion in 2009 with an ex vessel value of nearly $151 million. The greatest shellfish landings were also in 2009 with more than 364 million pounds valued at nearly $493 million. The majority of the shellfish and finfish harvest and the highest landings value occurred in Louisiana from 2008-2010 (NOAA 2011f).

3.4.6.2 Shellfish Fishery

The Gulf of Mexico is the top shellfish-producing region in the nation. In each state, some areas of State-owned water bottoms are managed as public commercial oyster reefs and/or leased to commercial harvesters with harvest rules and regulations varying by state. Shellfish quality is monitored by states adhering to strict controls from the U.S. Food and Drug Administration on shellfish growing, harvesting, processing, packaging, and transport. In all states, harvest is subject to periodic closure of areas due to water quality concerns, as determined by the appropriate state public health agency.

In Texas, there are 43 oyster leases on 2,322 acres of bottom, all within the Galveston Bay system. The oyster lease system in Texas exists for the purpose of relaying oysters from restricted waters to leases to reduce the incentive for poaching in restricted water (TPWD 2012b).

As of March 2012, in Louisiana, LDWF administrated 7,888 oyster leases totaling 391,143 acres (LDWF 2012c). Lessees have exclusive use of the water bottom at their leases, and are allowed to harvest year round, without restrictions on the harvest methods (e.g., dredge size) used. There is no minimum size for oysters harvested on a private lease, but all sacks of oysters must be tagged with the lease number prior to sale. Areas that have been set aside as public oyster beds or for coastal protection, conservation, or restoration are not leased.

The Mississippi Commission on Marine Resources protects and conserves shellfish by regulating shellfish activities. There is limited use of oyster leases in Mississippi (MDMR 2012), and the Department of Marine Resources (DMR) manages 12,000 acres of public, commercial oyster reefs; NRDA Early Restoration funding in fall 2012 and spring 2013 restored 1,430 acres of reef. Approximately 97% of the commercially harvested oysters in Mississippi come from reefs in the western part of the Mississippi Sound, primarily from Pass Marianne, Telegraph, and Pass Christian reefs (MDMR 2011).

Alabama Department of Conservation and Natural Resources (ADCNR), Marine Resources Division is responsible for the management of Alabama's oyster reefs. Harvest is also regulated by the Alabama Department of Public Health. The total public reefs including historically harvested reef footprints cover approximately 5300 acres which includes reefs in Mississippi Sound and Portersville Bay.

In Alabama, private oyster beds adjacent to riparian and leased areas are harvested commercially. The area of the riparian and leased water bottoms in which these private, commercially harvested, oyster beds are found currently totals approximately 870 acres. Alabama's public oyster reefs are open seasonally to commercial and recreational harvest. Commercial harvest requires the harvester to have

an annual oyster catcher's license. Oysters may be harvested recreationally without obtaining a permit or fishing license. Recreational harvesters are limited to 100 3" oysters per person per day and may harvest only in areas opened to commercial harvest. Harvest methods and practices are closely regulated by the state (ADCNR 2013).

Florida's Division of Aquaculture is responsible for leasing the submerged state lands and water column for producing aquaculture products (Florida Department of Agriculture and Consumer Service 2011), and wild harvest of shellfish is regulated by the Florida Fish and Wildlife Conservation Commission. As of March 2012, the State is administering 15 oyster leases on 661 acres, and 560 hardshell clam leases covering about 1,320 acres, along the state's Gulf Coast (Florida Division of Aquaculture 2012). Along Florida's Gulf Coast, the majority of oysters harvested are caught on public reefs (Florida Division of Aquaculture 2012). On private oyster leases, there is no size limit or closed season, and unlike harvest on public reefs, where only tonging is allowed, oysters on private leases can be dredged. Florida is the only Gulf State where clams are harvested on private leases (Florida Division of Aquaculture 2012).

3.4.6.3 Seafood Processing and Sales

After fish and shellfish are landed, they move into the seafood processing and sales industry. In 2009, thirty counties and parishes along the Gulf Coast had economic activity in this sector. There were a total of 86 establishments in the fish processing sector. In terms of employment and income, the restaurant sector contributed the most to employment and income of the seafood industry sectors in Texas, Louisiana, Mississippi, and Alabama. In Florida, the seafood importing and brokering sector generated more jobs and greater income than the restaurant sector. Restaurants also generated greater business sales than the other seafood industry sectors in Louisiana, Mississippi, and Alabama, but in Texas and Florida, business sales generated by seafood importing and brokering were greater than those for restaurants. In Texas, the seafood importing and brokering and restaurant sectors generated similar value added. In Mississippi and Alabama, the restaurant sector generated more value added than other seafood industry sectors, but the primary dealer/processor sector also generated significant value added. In Florida, the importing and brokering sector generated by far the greatest value added of any seafood industry sectors in that state.

3.4.7 Aquaculture

NMFS (2011f) defines aquaculture as "…the propagation and rearing of aquatic organisms in controlled or selected aquatic environments for any commercial, recreational, or public purpose." The Census of Aquaculture targets, "all commercial or noncommercial places from which $1,000 or more of aquaculture products were produced and either sold or distributed during the census year" (USDA National Agricultural Statistics Service 2006). Noncommercial operations include Federal, State, and tribal hatcheries (USDA National Agricultural Statistics Service 2006). This section primarily addresses commercial aquaculture.

Table 3-10 summarizes the various categories of aquaculture in terms of number of farms with aquaculture sold and the value of the products sold. As a total, there are more crustacean farms in coastal areas than any other type of aquaculture farm; however, more counties have freshwater catfish farms. Mollusks, valued at more than $50 million, were the most valuable aquaculture product sold.

Table 3-10. Summary of categories of aquaculture.

AQUACULTURE CATEGORY	FARMS IN STUDY AREA	COUNTIES/PARISHES WITH FARMS	VALUE ($1,000)*
Catfish	96	35	> $6,255
Trout	8	6	> $0
Other food fish	36	19	> $13,591
Baitfish	11	5	> $11
Crustaceans	229	30	> $10,939
Mollusks	192	18	> $50,252
Ornamental fish	134	26	> $23,123
Sport or game fish	29	16	> $5
Other aquaculture products	60	20	> $15,911
*For many farms, value was not disclosed, so the figures presented here are minimums. Source: USDA 2009, 2007 Census of Agriculture.			

Table 3-11 shows the change in number of saltwater aquaculture farms and acreage by state from 1998 to 2005. Louisiana had the most dramatic increase, from an undisclosed number of acres on 2 farms in 1998 to almost 216,000 acres on 135 farms in 2005. The saltwater acreage in Louisiana represents 66% of all saltwater aquaculture acreage in the United States (USDA 2005).

The GMFMC has approved an Aquaculture FMP. The purpose of the FMP is to establish a regional permitting process to manage the development of an offshore aquaculture industry in the Federal waters of the Gulf of Mexico. The goal of the aquaculture plan is to supplement wild caught fisheries with reared species in order to increase the maximum sustainable yield. NOAA is currently developing the implementing regulations for this FMP.

Table 3-11. Number and Acreage of Saltwater Aquaculture Farms by State, 1998 and 2005.

STATE	1998		2005	
	FARMS	ACRES	FARMS	ACRES
Texas	10	1,726	19	2,432
Louisiana	2	D	135	215,770
Mississippi	0	0	1	D
Alabama	0	0	2	D
Florida	226	1,353	163	718
D – Data were withheld to avoid disclosing data for individual farms. Source: USDA 2005, 2005 Census of Aquaculture. Updated data not available.				

3.4.7.1 Stock Enhancement

Stock enhancement is a form of aquaculture (discussed in section 3.4.7) in which larval or juvenile organisms are reared in a hatchery setting and then released into the natural environment in an attempt to bolster natural populations. Several northern Gulf States have active finfish stock enhancement programs that focus on increasing recreational catch. Texas releases 25 to 30 million red drum, several million spotted seatrout, and several thousand southern flounder fingerlings into the natural environment every year. Mississippi releases spotted sea trout and red snapper, and Florida releases red drum.

Table 3-12. Recreational harvest of key species/species groups in 2009 (thousands of fish).

SPECIES	TEXAS[a]	LOUISIANA	MISSISSIPPI	ALABAMA	WEST FLORIDA
Sharks[b]	-	-	12	-	-
Common snook	-	-	-	-	15
Gray snapper	-	-	-	-	1,124
Red snapper	31	104	18	196	-
Mullets (including striped mullets)	-	-	194	-	564
Bluefish	-	-	-	21	-
Black drum (croaker)	98	503	-	-	-
Drum (Atlantic croaker)	117	624	323	343	-
Drum (Gulf and southern kingfish)	-	133	159	735	-
Drum (sand and silver seatrouts)	111	1,003	1,009	1,448	828
Drum (spotted seatrout)	810	9,913	805	411	1,438
Red drum	285	2,240	66	58	256
King mackerel	16	-	-	-	368
Spanish mackerel	-	-	-	95	1,286
Yellowfin tuna	-	6	-	-	-
Gag (grouper)	-	-	-	-	222
Porgies (sheepshead)	34	775	44	174	764
Southern flounder	47	308	178	90	-

[a] Texas data collected by TPWD.
[b] Sharks include species within the requiem shark family, blacktip sharks, Atlantic sharpnose sharks, and unidentified sharks.
Source: NOAA Fisheries Service 2011i.

3.4.8 Marine Transportation

Marine transportation is an important component of the northern Gulf of Mexico regional economy, and the Gulf Coast is a major shipping center. The U.S. economy relies heavily on the ports in the northern Gulf of Mexico region for the import and export of both foreign and domestic goods. About fifty percent of all U.S. international trade tonnage passed through the Gulf of Mexico in 2009. This industry is dependent upon navigation services for safe and efficient operations. These services include maintaining shipping channels and aids to navigation. The USACE is largely responsible for the maintenance and improvement of the navigation system consisting primarily of the annual dredging of hundreds of millions of cubic yards of sediment from ports, harbors, and waterways throughout the Gulf of Mexico region to maintain navigable depths and widths (EPA/USACE 2007 as cited in GOMA 2009). Figure 3-14 shows major shipping lanes. The region's navigable waterways include natural and maintained rivers, lakes, bays, sounds, canals, navigation channels, etc., and include major civil works such as the GIWW and deep water access channels for major ports.

3.4.9 Aesthetics and Visual Resources

Aesthetics and visual resources define the visual character of an area. These resources can be natural features, vistas, or viewsheds and can include urban or community features such as architecture, skylines, or other man made characteristics. The current Gulf of Mexico coastal region is characterized by thousands of miles of shoreline, which is bordered by a variety of landscapes, including natural and maintained beaches, mangroves and other wetlands, developed areas such as towns and urban centers, as well as heavily industrialized areas including ports and infrastructure related to energy production.

Given the diversity of visual resources in this region, driving for pleasure in a natural setting is an extremely popular recreational activity in the coastal region of the northern Gulf of Mexico. Through "America's Byways," the U.S. Department of Transportation (DOT) Federal Highway Administration recognizes certain roads in the United States for their archeological, cultural, historic, natural, recreational, and/or scenic qualities and importance (America's Byways 2011). The program has identified many scenic byways (i.e., routes) in the Gulf Coast region: Creole Nature Trail, Great River Road, Alabama's Coastal Connection, Big Bend Scenic Byway, Florida Keys Scenic Highway, MS Beach Boulevard, MS Byways to Space, MS Highway 67, and MS Highway 605. These routes pass through coastal and upland portions of Louisiana, Alabama, Mississippi and Florida. There are many other ways to experience the visual and aesthetic resources of the Gulf Coast as well (e.g. boating and hiking).

3.4.10 Public Health and Safety

Public health and safety issues relate to the short-term construction of projects and long-term operations and maintenance. Additional discussion of the potential for direct or indirect impacts to public health and safety within the Gulf Coast Region is found in the individual proposed project descriptions and discussion of possible environmental consequences for individual proposed projects.

Provision of public health and safety can be complicated by large storm events such as tropical storms and hurricanes (and associated storm surges, winds, and battering waves) that have historically caused extensive damage to the shoreline as well as infrastructure such as roadways, bridges and buildings. The Gulf's coastal communities are at increased risk for severe shoreline damage and storm surges. More than half of the nation's population lives in coastal counties in densities five times greater than inland counties (NOAA, 2009). Coastal development has accelerated wetlands loss, as well as the loss of other coastline protections including reefs, barrier islands, tidal marshes and sand dunes along the Gulf Coast. These losses contribute to the damage and public health and safety threat large storm events pose to the communities and individuals in the Gulf Coast region.

During these large storm events, public safety personnel and facilities may be cut off from individuals caught in the path of the storm, thereby limiting the ability of police, fire and rescue personnel to reach affected populations. In addition, these affected populations may not be able to evacuate or access hospitals or emergency shelters if roadways or other infrastructure become impassable.

3.4.11 Flood and Shoreline Protection

Flood control refers to all methods used to reduce or prevent the detrimental effects of flood waters, including the construction of floodways (man-made channels to divert floodwater), levees, lakes, dams, reservoirs, or gates to hold extra water during times of flooding. Shoreline protection consists of engineered structures, living shorelines or other solutions meant to slow erosion by rising sea levels and wave action.

The USACE civil works programs and services include water resources development such as flood control, navigation, recreation, infrastructure, and environmental stewardship. These projects include structural projects and beach nourishment (USACE 2003). In addition, the USACE owns lands associated with these programs and services.

There are more than 30 USACE projects in the Galveston District including ecosystem restoration, floodgates, locks, waterways, ports, ship channels, harbors, rivers, lakes, dams, reservoirs, flood control projects, and recreation areas. The largest project is the Galveston seawall, which is 10 miles long and approximately 17 feet high, originally constructed in 1904 and extended to its current length by 1963 (USACE 1981).

The Mississippi River and Tributaries Project the largest flood control project in the world, includes several flood control elements including the Old River Control structure, the Morganza floodway and Bonnet Carré spillway. These projects are managed by the New Orleans District of the USACE. The Morganza floodway, along with the Atchafalaya River, pass floodwaters into the Lower Atchafalaya Basin Floodway. Farther downstream, these floodwaters enter the Gulf of Mexico through the Atchafalaya River below Morgan City and the Wax Lake Outlet (USACE n.d.). The Bonnet Carré spillway is the southernmost floodway in the Mississippi River and Tributaries project, and is a popular recreational area. Located in St. Charles Parish, Louisiana, the spillway reduces risk for New Orleans and other downstream communities during major floods on the Mississippi River. This risk reduction is accomplished by diverting a portion of the floodwaters into Lake Pontchartrain and then into the Gulf of Mexico, bypassing New Orleans (USACE 2012).

USACE projects in Mississippi include projects authorized under the Mississippi Coastal Improvement Plan (MsCIP), which provides funding for major barrier island restoration, risk reduction strategies for areas of Mississippi, and ecological restoration of numerous coastal MS habitats (USACE 2009). It also includes the High Hazard Area Risk Reduction Plan which provides for the purchase of at-risk properties along Coastal Mississippi.

3.5 References

Alabama Department of Conservation and Natural Resources (ADCNR). 2008b. Fish and Fishing in the Mobile Delta. Website accessed on August 8, 2013: http://www.outdooralabama.com/fishing/freshwater/where/rivers/delta/.

------. 2011a. Alabama beach mouse. Website accessed on August 1, 2011: www.outdooralabama.com/watchablewildlife/what/Mammals/Rodents/abm.cfm.

------. 2011b. Perdido Key beach mouse. Website accessed on August 2, 2011: http://www.outdooralabama.com/watchable-wildlife/what/Mammals/Rodents/pkbm.cfm.

------. 2011c. Alabama State Parks. Website accessed on November 4, 2011: http://www.alapark.com/Parks/.

Alperin, L.M.. 1983. "History of the Gulf Intracoastal Waterway". National waterways study, Navigation History NWS-83-9. 89 pages.

America's Byways. 2011. *Learn About Byways*. Downloaded from the website: http://byways.org/learn/.

American Bird Conservancy. 2003. The American Bird Conservancy Guide to the 500 Most Important Bird Areas in the United States: Key Sites for Birds and Birding in All 50 states. Robert M. Chipley, George H. Fenwick, Michael J. Parr, and David N. Pashley. Random House Trade Paperbacks.

Barataria Terrebonne National Estuary Program (BTNEP). 2012. Cheniere Habitats. Cheniere Ridges: Mother Nature's Premier Birding Opportunities. Website accessed on February 29, 2012: http://www.btnep.org/subsites/grandisle/eventhistory/ChenierHabitats.aspx.

Beck,M.W., R.D. Brumbaugh, L. Airoldi, A. Carranza, L.D. Coen, C. Crawford, O. Defeo, G.J. Edgar, B. Hancock, M. Kay, H. Lenihan, M.W. Luckenbach, C.L. Toropova, G. Zhang. 2009. Shellfish Reefs at Risk: A Global Analysis of Problems and Solutions. The Nature Conservancy, Arlington VA. 52 pp.

Biggs, D.C., and P.H. Ressler. 2001. Distribution and abundance of phytoplankton, zooplankton, ichthyoplankton, and micronekton in the deepwater Gulf of Mexico. Gulf of Mexico Science 19:7-29.

Bjorndal, K.A., and J.B.C. Jackson. 2003. Roles of sea turtles in marine ecosystems: Reconstructing the past, pp. 259-273 in The Biology of Sea Turtles Volume II (P.L. Lutz, J.A. Musick, and J. Wyneken, eds.). CRC Press, Boca Raton, Florida (USA).

Borden, Shonda. 2005. The Beach Mouse. Mississippi-Alabama Sea Grant Consortium. Website accessed on October 17, 2012: http://www.masge.org/page.asp?id=161.

Bouchard, S.S., and K.A. Bjorndal. 2000. Sea turtles as biological transporters of nutrients and energy from marine to terrestrial ecosystems. Ecology 81: 2305-2313.

Bowen, W.D. 1997. Role of marine mammals in aquatic ecosystems. Marine Ecology Progress Series158:267-274.

Bricker, S.B., C.G. Clement, D.E. Pirhalla, S.P. Orlando, and D.R.G. Farrow. 1999. National Estuarine Eutrophication Assessment. Effects of Nutrient Enrichment in the Nation's Estuaries. National Oceanic and Atmospheric Administration (NOAA) Ocean Service Special Projects Office.

Brown, C., K. Andrews, J. Brenner, J.W. Tunnell, C. Canfeld, C. Dorsett, M. Driscoll, and E. Johnson, S. Kaderka. 2011. Strategy for Restoring the Gulf of Mexico (A cooperative NGO report). The Nature Conservancy. Arlington, Virginia. 23 pp.

Bureau of Energy Management (BOEM). 2011. OCS Alternative Energy and Alternate Use Programmatic EIS Information Center. The Outer Continental Shelf. Website accessed on December, 27, 2011: http://ocsenergy.anl.gov/guide/ocs/index.cfm.

------. 2012. Outer Continental Shelf Oil and Gas Leasing Program: 2012-2017 Final Programmatic Environmental Impact Statement. OCS EIS/EA BOEM 2012-030. United States Department of the Interior, Bureau of Ocean Energy Management. July. Downloaded from the website: http://www.boem.gov/uploadedFiles/BOEM/Oil_and_Gas_Energy_Program/Leasing/Five_Year_Program/2012-2017_Five_Year_Program/00_Contents_and_Summary.pdf

Capital Regional District. 2012. Otter. Website accessed on October 17, 2012: http://www.crd.bc.ca/watersheds/protection/wildlife-_plants/otters.htm.

Chmura, G. L., S. C. Anisfeld, D. R. Cahoon, and J. C. Lynch. 2003. Global carbon sequestration in tidal, saline wetland soils. Global Biogeochem. Cycles 17(4):1111; doi:10.1029/2002GB001917.

Choi, Y., and Y. Wang. 2004. Dynamics of carbon sequestration in a coastal wetland using radiocarbon measurements, *Global Biogeochem. Cycles* 18, GB4016, doi:10.1029/2004GB002261.

Coastal Protection and Restoration Authority (CPRA). 2012. Louisiana's Comprehensive Master Plan for a Sustainable Coast. Available at: http://issuu.com/coastalmasterplan/docs/coastal_master_plan-v2?e=3722998/2447530.

Coastal Travel Guide. 2012. *Coastal Travel Guide; Outdoor Recreation, Tourism, and Travel*. Downloaded from the website: http://www.coastaltravelguide.com/.

Coen L.D., R.D. Brumbaugh, D. Bushek, R. Grizzle, M.W. Luckenbach, M.H. Posey, S.P. Powers, and G.S. Tolley. 2007. AS WE SEE IT: Ecosystem services related to oyster restoration. *Marine Ecology Progress Series* 341:303-307.

Committee on Environment and Natural Resources. 2010. Scientific Assessment of Hypoxia in U.S. Coastal Waters. Interagency Working Group on Harmful Algal Blooms, Hypoxia, and Human Health of the Joint Subcommittee on Ocean Science and Technology, Washington, DC.

Conant, R., and J.T. Collins. 1991. *Reptiles and Amphibians*. Eastern/Central North America. Peterson Field Guides. Houghton Mifflin Company, New York, New York. Page 39.

Coston-Clements, L., L.R. Settle, D.E. Hoss, and F.A. Cross. 1991. *Utilization of the Sargassum Habitat by Marine Invertebrates and Vertebrates – A Review*. National Oceanic and Atmospheric Administration Technical Memorandum NMFS-SEFSC-296. 32 pp.

Council on Environmental Quality (CEQ). 1997. *Environmental Justice: Guidance under the National Environmental Policy Act.* Downloaded from the website: http://www.epa.gov/compliance/ej/resources/policy/ej_guidance_nepa_ceq1297.pdf.

-----. 2010. Draft NEPA guidance on consideration of the effects of climate change and greenhouse gas emissions. Memorandum for heads of Federal departments and agencies. February 18, 2010.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. *Classification of Wetlands and Deepwater Habitats of the United States.* FWS/OBS-79/31. United States Fish and Wildlife Service, Washington, D.C. December.

Dahl, T.E. and S.M. Stedman. 2013. Status and trends of wetlands in the coastal watersheds of the Conterminous United States 2004 to 2009. U.S. Department of the Interior, Fish and Wildlife Service and National Oceanic and Atmospheric Administration, National Marine Fisheries Service, p.46.

Dale et al. 2010. Hypoxia in the Northern Gulf of Mexico. Available at the website: http://www.springer.com/environment/environmental+management/book/978-0-387-89685-4.

DeGraaf, R. M., Yamasaki, M. 1986. New England wildlife: habitat, natural history, and distribution. Gen. Tech. Rep. NE-108. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 491 p.

Dennis, G.D. and Bright, T.J. 1988. New records of fishes in the northwestern Gulf of Mexico, with notes on some rare species. Northeast Gulf Science: 10(1), 1-18.

Duke, Thomas, and William Kruczynski, Editors. 1992. *Status and Trends of Emergent and Submerged Vegetated Habitats, Gulf of Mexico, U.S.A*. EPA 800-R-92-003. United States Environmental Protection Agency, Office of Water Gulf of Mexico Program, Stennis Space Center, Mississippi. 184 pp.

Eastern Oyster Biological Review Team. 2007. *Status Review of the Eastern Oyster (Crassostrea virginica)*. Report to the National marine Fisheries Service, Northeast Regional Office. February 16, 2007. 105 pp.

Esslinger, C.G., and B.C. Wilson. 2002. *North American Waterfowl Management Plan, Gulf Coast Joint Venture: Chenier Plain Initiative*. North American Waterfowl Management Plan, Albuquerque, New Mexico. Revised 2003.

Felder, D.L., and D.K. Camp. 2009. *Gulf of Mexico Origin, Waters, and Biota* (J.W. Tunnell, Jr., D.L. Felder, and S.A. Earle, Editors). Harte Research Institute for Gulf of Mexico Studies Series 1, 1393. Texas A&M University Press, College Station.

Fertl, D., A.J. Schiro, G.T. Regan, C.A. Beck, N. Adimey, L. Price-may, A. Amos, G.A.J. Worthy, and R. Crossland. 2005. Manatee occurrence in the northern Gulf of Mexico, West of Florida. Gulf and Caribbean Research 17:69-94.Fischer, Richard A., Chester O. Martin, John T. Ratti, and John Guidice. 2001 *Riparian Terminology: Confusion and Clarification*. ERDC TN-EMRRP-SR-25. U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

Fisher and Acreman. 2004. *Wetland Nutrient Removal: a review of the evidence.* Downloaded from the website: http://www.hydrol-earth-syst-sci.net/8/673/2004/hess-8-673-2004.pdf.

Florida Department of Agriculture and Consumer Services. 2011. Aquaculture. The Florida Legislature Office of Program Policy Analysis and Government Accountability. Accessed on October 10, 2011. http://www.oppaga.state.fl.us/profiles/4142/.

Florida Department of Environmental Protection (FDEP). 2011. Recreation and Parks: About Florida State Parks. Website accessed on November 4, 2011: http://www.dep.state.fl.us/parks/.

Florida Division of Aquaculture. 2012. Personal communication with Leslie Palmer, Director of Aquaculture, Division of Aquaculture, Florida Department of Agriculture and Consumer Services. March 8, 2012.

Florida Fish and Wildlife Conservation Commission (FWC) . 2007. *Florida Manatee Management Plan Trichechus manatus latirostris*. Tallahassee, Florida. December.

Florida State Parks. N.d. *Welcome to Anclote Key Preserve State Park*. Website accessed on November, 3 2011: http://www.floridastateparks.org/anclotekey/default.cfm.

Forbes, M. G., J. Back, R. Doyle. 2012. Nutrient transformation and retention by Coastal Prairie wetlands, Upper Gulf Coast, Texas. Wetlands 32:705-715.

Gibeaut Jim and Melba Crawford. 1996. Modeling Vegetation and Topographic Changes on the Barrier Islands. Website accessed on October 10, 2012: http://www.csr.utexas.edu/projects/rs/bolivar.html.

Gihring, T.M., M. Humphrys, H.J. Mills, M. Huettell, and J.E. Kostka. 2009. Identification of a phytodetritus-degrading microbial community in sublittoral Gulf of Mexico sands. *Limnology and Oceanography* 54(4):1073-1083.

Gilbes, F., T. Carmelo, J.J. Walsh, and F.E. Muller-Karger. 1996. An episodic chlorophyll plume on the West Florida Shelf. *Continental Shelf Research* 16(9):1201-1207.

Gower, J., and S. King. 2008. *Satellite Images Show the Movement of Floating Sargassum in the Gulf of Mexico and Atlantic Ocean*. Nature Precedings. Posted May 2008.

Grabowksi, J.H., A.R. Hughes, D.L. Kimbro, and M.A. Dolan. 2005. How habitat setting influences restored oyster reef communities. *Ecology* 86(7):1926-1935.

Grabowski, J.H., and C.H. Peterson. 2007. Restoring oyster reefs to recover ecosystem services, pp. 281-298 in *Ecosystem Engineers, Plants to Protists* (K. Cuddington, J.E. Byers, W.G. Wilson, and A. Hastings, Editors). Edited Book Chapter in Ecosystem Engineers. Elsevier Academic Press, Burlington, Massachusetts.

Greene, C.R. 1995. Ambient noise. Richardson, W.J, Greene, C.R., Malme, C.I., and Thomson, D.H. (Eds.). Marine Mammals and Noise. Academic Press.

Griffin, DuBose, David Owens, and J. Whitfield Gibbons. N.d. Diamondback Terrapin. South Carolina Department of Natural Resources. Website accessed on October 12, 2011: http://www.dnr.sc.gov/cwcs/pdf/DiamondbackTerrapin.pdf.

Gulf-At-A-Glance, published by GOMA in 2008, p. 12. http://gulfofmexicoalliance.org/pdfs/gulf_glance_1008.pdf.

Gulf Coast Ecosystem Restoration Task Force (GCERTF). 2011. *Gulf of Mexico Regional Ecosystem Restoration Strategy*. Downloaded from the website: http://www.epa.gov/gulfcoasttaskforce/pdfs/GulfCoastReport_Full_12-04_508-1.pdf.

Gulf Coastal Prairie Working Group. 2000. *U.S. Shorebird Conservation Plan, Lower Mississippi / Western Gulf Coast Shorebird Planning Region*. Coordinated by Lee Elliott. April.

Gulf of Mexico Alliance. 2009. *Technical Framework for the Gulf Regional Sediment Management Master Plan (GRSMMP)*. Developed by the Habitat Conservation and Restoration Team. September.

Website accessed on October 24, 2012: http://gulfofmexicoalliance.org/pdfs/GRSMMP_Technical_Framework_Dec_09.pdf

------. 2011a. Master plan for the Beneficial Use of Dredged material Along Coastal Mississippi. Downloaded from the website: http://www.gulfmex.org/1170/rsm-master-plan-update-for-beneficial-uses-of-dredged-material-along-coastal-mississippi/

------. 2011b. Project Management Plan for Selected Beneficial Use Projects Along Coastal Mississippi. September.

Gulf of Mexico Fishery Management Council (GMFMC). n.d. Fishery management plans and amendments. Retrieved on August 20, 2013 from: http://www.gulfcouncil.org/fishery_management_plans/index.php.

------.2004. *Final Environmental Impact Statement for the Generic Essential Fish Habitat Amendment to the Following Fishery Management Plans of the Gulf of Mexico (GOM): Shrimp Fishery of the Gulf of Mexico, Red Drum Fishery of the Gulf of Mexico, Reef Fish Fishery of the Gulf, Stone Crab Fishery of the Gulf of Mexico, Coral and Coral Reef Fishery of the Gulf of Mexico, Spiny Lobster Fishery of the Gulf of Mexico and South Atlantic, and Coastal Migratory Pelagic Resources of the Gulf of Mexico and South Atlantic. Volume 1: Text*. National Oceanic and Atmospheric Administration Award No. NA17FC1052. Tampa, Florida. March. Available [online]: http://www.gulfcouncil.org/Beta/GMFMCWeb/downloads/Final%20EFH%20EIS.pdf.

------. 2005. *Final Generic Amendment Number 3 for Addressing Essential Fish Habitat Requirements, Habitat Areas of Particular Concern, and Adverse Effects of Fishing in the following Fishery Management Plans of the Gulf of Mexico: Shrimp Fishery of the Gulf of Mexico, United States Waters Red Drum Fishery of the Gulf of Mexico Reef Fish Fishery of the Gulf of Mexico Coastal Migratory Pelagic Resources (Mackerels) in the Gulf of Mexico and South Atlantic Stone Crab Fishery of the Gulf of Mexico Spiny Lobster in the Gulf of Mexico and South Atlantic Coral and Coral Reefs of the Gulf of Mexico*. Tampa, Florida.

Gulf Restoration Network. 2001. *A Guide to Protecting Wetlands in the Gulf of Mexico*. Website accessed on December 29, 2011: http://healthygulf.org/files_reports/healthy_waters/reports/A_Guide_to_Protecting_Wetlands_in_the_Gulf_of_Mexico.pdf.

Gulf States Marine Fisheries Commission (GSMFC). 2012. *The Oyster Fishery of the Gulf of Mexico, United States: A Fisheries Management Plan*. Prepared by the Oyster Technical Task Force. March.

GulfBase. 2012. Cat Island website: http://www.gulfbase.org/reef/view.php?rid=cat. Accessed on October 10, 2012.

IPCC. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Jochens, A.E., L.C. Bender, S.F. DiMarco, J.W. Morse, M.C. Kennicutt II, M.K. Howard, and W.D. Nowlin, Jr. 2005. *Understanding the Processes that Maintain the Oxygen Levels in the Deep Gulf of Mexico: Synthesis Report.* United States Department of the Interior, Minerals Management Service (MMS), Gulf of Mexico Outer Continental Shelf (OCS) Region, New Orleans, Louisiana. OCS Study MMS 2005-032.

Johnson, D.L., and Horwath Burnham, J.L., 2012, Introduction: Overview of concepts, defi nitions, and principles of soil mound studies, in Horwath Burnham, J.L., and Johnson, D.L., eds., Mima Mounds: The Case for Polygenesis and Bioturbation: Geological Society of America Special Paper 490, p. 1–19

Karl, Thomas R., Jerry Melillo, and Thomas C. Peterson. 2009. *Global Climate Change Impacts in the United States*. United States Global Change Research Program (Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, Editors). Cambridge University Press.

Kilgen, R . H ., and R . J . Dugas . 1989 . The ecology of oyster reefs of the northern Gulf of Mexico : an open file report . NWRC-open file rep . 89-02 . 113 PP

Lacey, E., J. Patton, G. Cameron (eds.). 2000. Life Undergound: the biology of subterranean rodents. University of Chicago Press, 449 pp

Livingston, R.J. 2003. *Trophic Organization in Coastal Systems*. Marine Science Series. CRC Press, Boca Raton, Florida.

Louisiana Department of Culture, Recreation, and Tourism. 2011. *Louisiana State Parks*. Website accessed on November 4, 2011: http://www.crt.state.la.us/parks/iparkslisting.aspx.

Louisiana Department of Wildlife and Fisheries. 2012. Oyster stock assessment report of the public oyster areas in Louisiana seed grounds and seed reservations. Website accessed on May 25, 2012: http://www.wlf.louisiana.gov/sites/default/files/pdf/page_fishing/32695-Oyster%20Program/2012_oyster_stock_assessment.pdf.

Lynam, C.P., M.J. Gibbons, B.E. Axelsen, C.A.J. Sparks, J. Coetzee, B.G. Heywood, and A.S. Brierley. 2006. Jellyfish overtake fish in a heavily fished ecosystem. *Current Biology* 16(13): R492-R493.

McEachran and Fechhelm. 1998. http://utpress.utexas.edu/index.php/books/mcefis.

McKenna, Kimberly, Texas Coastwide Erosion Response Plan, Final Report, 2009, 196p.

McKinney, Brad. 2009. *Pelagic Birds of Texas: Status and Distribution, Seabirds of the Lower Texas Coast*. Downloaded from the website: http://www.texaspelagics.com/Seabirds%20of%20the%20Lower%20Texas%20Coast%20rev%2009-2009.pdf.

Milly, P.C.D., and Dunne, K.A., 2001, Trends in evaporation and surface cooling in the Mississippi River basin: Geophys. Res. Lett., v. 28, p. 1219-1222.

Mineral Management Service (MMS). 2007. *Outer Continental Shelf Oil & Gas Leasing Program: 2007-2012*. Final Environmental Impact Statement April 2007. Volume I. OCS EIA/EA MMS 2007-003. Downloaded from the website: http://www.boemre.gov/5-year/2007-2012FEIS.htm.

Mississippi Department of Marine Resources (MDMR). 2011. *Part 1 Rules and Regulations for Shellfish Harvesting, Tagging, Landing, Unloading, Transporting, Relaying, Management, Area Classification, and Other Shellfish Related Activates in the State, and the Leasing of Territorial Waters Under the Jurisdiction of the State of Mississippi*. Title 22 – Mississippi Department of Marine Resources. Website accessed on January 9, 2012: http://www.dmr.state.ms.us/ordinances/TITLE-22-PART-01.pdf.

------. 2012. Personal communication with Bradley Randall, Mississippi Department of Marine Resources. March 9, 2012.

------. 2012b. Mississippi oyster cultch restoration. Website accessed on May 25, 2014: http://www.gulfspillrestoration.noaa.gov/wp-content/uploads/2012/04/MississippiOysterCultchF.pdf

Mississippi State Parks. N.d. Campgrounds and camping reservations. Website accessed on November 4, 2011: http://mississippistateparks.reserveamerica.com/.

Morrison, M.L. 2006. *Bird Movements and Behaviors in the Gulf Coast Region: Relation to Wind Development. November 22, 2000-October 31, 2005.* National Renewable Energy Laboratory Subcontract Report NREL/SR-500-39572.

Morton, Robert A., Miller, Tara L., and Moore, Laura J., 2004, National assessment of shoreline change: Part 1: Historical shoreline changes and associated coastal land loss along the U.S. Gulf of Mexico: U.S. Geological Survey Open-file Report 2004-1043, 45p.

Moulton, D., T. Dahl, and D. Dall. 1997. Texas Coastal Wetlands: Status and Trends, Mid-1950s to Early 1990s. U. S. Department of the Interior, Fish and Wildlife Service, Albuquerque, New Mexico. 32 pages.

Moulton, D. and J. Jacob. 2000. Texas Coastal Wetlands Guidebook. Texas Sea Grant SG-00-605. 66 pp.

Murray, S.P. 1997. *An Observational Study of the Mississippi-Atchafalaya Coastal Plume: Final Report.* United States Department of the Interior, Minerals Management Service, Gulf of Mexico Outer Continental Shelf (OCS) Region, New Orleans, Louisiana. OCS Study MMS 98-0040. 513 pp.

National Fish and Wildlife Foundation. 2013. Restoration and enhancement of oyster reefs in Alabama. Website accessed on May 25, 2014: http://www.nfwf.org/gulf/Documents/al-oyster-reef-enhancement.pdf.

National Marine Protected Areas Center (NMPAC). 2010. *The National System of MPAs: Analysis of National System Sites (June 2010)*. Downloaded from the website: http://www.mpa.gov/pdf/helpful-resources/factsheets/nss_analysis_june_2010.pdf.

------. 2011a. *Definition and Classification System for U.S. Marine Protected Areas.* National Oceanic and Atmospheric Administration Ocean Service, Silver Spring, Maryland. Website accessed on November 3, 2011: http://www.mpa.gov/pdf/helpful-resources/factsheets/mpa_classification_may2011.pdf.

------. 2011b. *Snapshot of Gulf of Mexico MPAs*. National Oceanic and Atmospheric Administration Ocean Service, Silver Spring, Maryland. Website accessed on November 1, 2011: http://www.mpa.gov/pdf/helpful-resources/gom_mpas_snapshot.pdf.

-------. 2009. State of the Coast 1970-2020". Available at: http://stateofthecoast.noaa.gov/features/coastal-population-report.pdf

-------. 2010. *Oil Spills in Mangroves, Planning and Response Considerations*. National Ocean Service, Office of Response and Restoration. Reprinted July 2010.

-------. 2011. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments. (http://www.nmfs.noaa.gov/pr/pdfs/sars/ao2011.pdf)

------. 2011a. *The Gulf of Mexico At A glance: A Second Glance.* Downloaded from the website: http://stateofthecoast.noaa.gov/NOAAs_Gulf_of_Mexico_at_a_Glance_report.pdf.

------. 2011b. *National Estuarine Research Reserve System*. Website accessed on October 21, 2011. http://nerrs.noaa.gov/.

------. 2011d. *National Marine Protected Areas. De Facto Marine Protected Areas*. Website accessed on November 11, 2011: http://www.mpa.gov/dataanalysis/defacto/.

------. 2012a. Habitat website: Barrier Islands. Website accessed on September 27, 2012: http://www.habitat.noaa.gov/abouthabitat/barrierislands.html.

------. 2012b. *SEDAR 31, Gulf of Mexico Red Snapper.* SEDAR Workshop. http://www.sefsc.noaa.gov/sedar/Sedar_Documents.jsp?WorkshopNum=31&FolderType=Data.

------. 2012c. Blue Crab. Website Accessed on October 3, 2013. http://www.sefsc.noaa.gov/sedar/Sedar_Documents.jsp?WorkshopNum=31&FolderType=Data.

------. 2012e. Annual Commercial Landings Statistics. Website accessed on October 23, 2012: http://www.st.nmfs.noaa.gov/pls/webpls/MF_ANNUAL_LANDINGS.RESULTS.

------. 2012f. Striped Dolphin *(Stenella coeruleoalba)*, Office of Protected Resources Marine Mammals. Website accessed on March 9, 2012: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/stripeddolphin.htm.

------. 2012g. Report on the Ocean and Great Lakes Economy of the United States: ENOW Final Economic Report. NOAA Coastal Services Center. Available online at: http://www.csc.noaa.gov/digitalcoast/_/pdf/econreport.pdf.

------. 2012h. The Marine Protected Areas Inventory. Available at: http://marineprotectedareas.noaa.gov/dataanalysis/mpainventory/.

------. 2012i. National Estuarine Research Reserve System. Available at: http://nerrs.noaa.gov/ReservesMap.aspx.

------. 2012j. Endangered and Threatened Species and Critical Habitats under the Jurisdiction of the NOAA Fisheries Service. Available at: http://sero.nmfs.noaa.gov/protected_resources/section_7/threatened_endangered/Documents/southeast_region_03052014.pdf.

-------. 2013b. National Marine Sanctuaries. Available at: http://sanctuaries.noaa.gov/about/legislation/welcome.html

National Oceanic and Atmospheric Administration (NOAA) Fisheries Service. 2009. *Smalltooth Sawfish Recovery Plan*. Downloaded from the website: http://www.nmfs.noaa.gov/pr/pdfs/recovery/smalltoothsawfish.pdf.

-------. 2010. *Essential Fish Habitat: A Marine Fish Habitat Conservation Mandate for Federal Agencies*. Gulf of Mexico Region. Habitat Conservation Division, Southeast Regional Office. St. Petersburg, Florida. Revised September.

------. 2011a. Loggerhead Turtle (*Caretta caretta*). Office of Protected Resources. Website accessed on November 7, 2011: http://www.nmfs.noaa.gov/pr/species/turtles/loggerhead.htm.

-------. 2011b. *Endangered and Threatened Species; Determination of Nine Distinct Population Segments of Loggerhead Sea Turtles as Endangered or Threatened*. Downloaded from the website: http://www.nmfs.noaa.gov/pr/pdfs/species/loggerhead_listing_finalrule_filed.pdf.

------. 2011c. Kemp's Ridley Turtle (*Lepidochelys kempii*). Office of Protected Resources. Website accessed on November 7, 2011: http://www.nmfs.noaa.gov/pr/species/turtles/kempsridley.htm.

------. 2011d. Leatherback Turtle (*Dermochelys coriacea*). Office of Protected Resources. Website accessed on November 7, 2011: http://www.nmfs.noaa.gov/pr/species/turtles/leatherback.htm.

------. 2011e. *United States National Bycatch Report*. First Edition. NOAA Technical Memo NMFS-F/SPO-117C. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. William A. Karp, Lisa L. Desfosse, and Samantha G. Brooke, editors. September. Downloaded from the website: http://www.nmfs.noaa.gov/by_catch/BREP2011/2011_National_Bycatch_Report.pdf.

------. 2011f. *Fisheries Economics of the United States, 2009*. United States Department of Commerce, NOAA Technical Memorandum NMFS-F/SPO-118. 172 pp. Available online: https://www.st.nmfs.noaa.gov/st5/publication/index.html.

-------. 2011i. *Gulf of Mexico Regional Summary.* Downloaded from the website: http://www.st.nmfs.noaa.gov/Assets/economics/documents/feus/2011/FEUS2011%20-%20Gulf%20of%20Mexico.pdf.

------. 2013. What is Essential Fish Habitat? Website accessed September 27, 2013: http://www.habitat.noaa.gov/protection/efh/index.html.

NOAA National Marine Fisheries Service (NMFS). 2009. Final Amendment 1 to the 2006 Consolidated Atlantic Highly Migratory Species Fishery Management Plan, Essential Fish Habitat. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Sustainable Fisheries, Highly Migratory Species Management Division, Silver Spring, MD. Public Document. pp. 395.

------.2011f. *National Oceanic and Atmospheric Administration Marine Aquaculture Policy.* Downloaded from the website: http://www.nmfs.noaa.gov/aquaculture/docs/policy/noaa_aquaculture_policy_2011.pdf.

National Wildlife Federation. 2012. *Grand Bay National Wildlife Refuge. Disappearing Wet Pine Savanna Under Attack*. Website accessed on October 18, 2012: http://www.nwf.org/Oil-Spill/Effects-on-Wildlife/Refuges-At-Risk/Grand-Bay-Refuge.aspx.

Nowlin, W.D. 1971. Water masses and general circulation of the Gulf of Mexico. *Oceanology* 5(2):28-33

Oceana. 2012. *Marine Places. Laguna Madre*. Website accessed on March 6, 2012: http://oceana.org/en/explore/marine-places/laguna-madre.

Omernik, J. and Griffith, G. 2008. Ecoregions of Louisiana (EPA). Available at: http://www.eoearth.org/view/article/152101/.

Pabody, C.M., R.H. Carmichael, L. Rice, and M. Ross. 2009. A new sighting network adds to 20 years of historical data on fringe West Indian manatee (*Trichechus manatus*) populations in Alabama Waters. Gulf of Mexico Science 2009(1):52-61.

Pajerski, L., B. Schechter, and R. Street. 2000. *Alligator mississippiensis.* University of Michigan Museum of Zoology Animal Diversity Web. Website accessed on October 12, 2011: http://animaldiversity.ummz.umich.edu/site/accounts/information/Alligator_mississippiensis.htm.

Peake, Dwight E., and Mark Elwonger 1996. A new frontier: pelagic birding in the Gulf of Mexico. *Winging It* 8(1):1-9.

Peterson, C.H., J.H. Grabowski, and S.P. Powers. 2003. Estimated enhancement of fish production resulting from restoring oyster reef habitat: quantitative valuation. *Marine Ecology Progress Series* 264:249-264.

Ribic, Christine A., Randall Davis, Nancy Hess, and Dwight Peake. 1997. Distribution of seabirds in the northern Gulf of Mexico in relation to mesoscale features: initial observations. International Council for the Exploration of the Sea (ICES). *Journal of Marine Science* 54:545-551.

Schechter, B., and R. Street. 2000. *Alligator mississippiensis* (On-line), Animal Diversity Web. Website accessed on October 19, 2012: http://animaldiversity.ummz.umich.edu/accounts/Alligator_mississippiensis/.

Shaver, D.J., Hart, K.M., Fujisaki, I., Rubio, C., Sartain, A.R., Pena, J., Burchfield, P.M., Gamez, D.G., Ortiz, J. 2013. Foraging area fidelity for Kemp's ridleys in the Gulf of Mexico. Ecology and Evolution 3(7): 2002-2012.

Short, F., Carruther, T., Dennison, W., and Waycott, M. 2007. Global seagrass distribution and diversity: a bioregional model. *Journal of Experimental Marine Biology and Ecology* 350:3-20.

Sibley, David. A. 2001. *The Sibley Guide to Bird Life and Behavior*. Alfred A. Knopf, New York.

Smithsonian National Museum of Natural History. n.d. North American Mammals: Northern River Otter. Website accessed on August 19, 2013: http://www.mnh.si.edu/mna/image_info.cfm?species_id=142.

Smithsonian National Zoological Park. N.d. North America, Facts, North American River Otter. Website accessed on January 11, 2012: http://nationalzoo.si.edu/Animals/NorthAmerica/Facts/fact-riverotter.cfm.

South Atlantic Fisheries Management Council (SAFMC). 2002. *Fishery Management Plan for Sargassum Habitat of the South Atlantic Region*. Second revised final. South Carolina. November. 228 pp.

Stone, G.W., and McBride, R.A. 1998. Louisiana barrier islands and their importance in wetland protection: forecasting shoreline change and subsequent response of wave climate. *Journal of Coastal Research* 14:900-915.

Sullivan, Janet. 1996. *Mustela vison*, in *Fire Effects Information System*. United States Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Website accessed on January 11, 2012: http://www.fs.fed.us/database/feis/animals/mammal/muvi/all.html.

Taylor, M.W., Hill, R.T., Piel, J., Thacker, R.W., and U. Hentschel. 2007. Soaking it up: the complex lives of marine sponges and their microbial associates. *International Society of Microbial Ecology* 1:187-190.

Terres, J.K. 1991. *The Audubon Society Encyclopedia of North American Birds*. Wing Books, New York. 1,109 pp.

Texas Department of Transportation. 2005. *Gulf Intracoastal Waterway Legislative Report*. Texas Department of Transportation, Austin Texas. Downloaded from the website: ftp://ftp.dot.state.tx.us/pub/txdot-info/library/reports/gov/tpp/giww05.pdf.

Texas Parks and Wildlife Department (TPWD). N.d.a. *Gulf Coast Travel Region of State Parks*. Website accessed on November 4, 2011: http://www.tpwd.state.tx.us/spdest/findadest/gulf_coast/.

------. N.d. Oysters in Texas Coastal Waters. Website accessed on May 25, 2014: http://www.tpwd.state.tx.us/fishboat/fish/didyouknow/oysterarticle.phtml.

------. 2011. Migration and Migratory Birds of Texas website: http://www.tpwd.state.tx.us/huntwild/wild/birding/migration/.

------. 2012a. *Gulf Salt Marsh Snake (Nerodia clarkii)*. Website accessed on June 11, 2012: http://www.tpwd.state.tx.us/huntwild/wild/species/gulfsnake/.

------. 2012b. GIS Download. Website accessed on October 24, 2012: http://www.tpwd.state.tx.us/landwater/land/maps/gis/map_downloads/map_gallery/hydro/index.phtmlUnited States Geological Survey (USGS). 2012. Coastal Conflicts website: http://pubs.usgs.gov/circ/c1075/conflicts.html.

------. 2013. Blue Crab (*Callinectes sapidus*). Website accessed on September 27, 2013: http://www.tpwd.state.tx.us/huntwild/wild/species/bluecrab/.

Thayer, Gordon W., Teresa A. McTigue, Russell J. Bellmer, Felicity M. Burrows, David H. Merkey, Amy D. Nickens, Stephen J. Lozano, Perry F. Gayaldo, Pamela J. Polmateer, and P. Thomas Pinit. 2003. Science-Based Restoration Monitoring of Coastal Habitats, Volume One: A Framework for Monitoring Plans Under the Estuaries and Clean Waters Act of 2000 (Public Law 160-457). National Oceanic and Atmospheric Administration (NOAA) Coastal Ocean Program Decision Analysis Series No. 23, Volume 1. NOAA National Centers for Coastal Ocean Science, Silver Spring, Maryland. 35 pp. plus appendices.

Thayer, G.W., K.A. Bjorndal, J.C. Ogden, S.L. Williams, and J.C. Zieman. 1984. Role of larger herbivores in seagrass communities: Functional ecology of seagrass ecosystems: A perspective on plant-animal interactions. *Estuaries* 7(4): 351-376.

Turner, R.E., Overton, E.B., Rabalais, N.N. and Sen Gupta, B.K. (eds.). 2003. Historical reconstruction of the contaminant loading and biological responses in the Central Gulf of Mexico shelf sediments. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2003-063. 140 pp.

United States Army Corps of Engineers (USACE). N.d. *The Atchafalaya Basin Project.* Website accessed on November 2, 2012: http://www.mvn.usace.army.mil/pao/bro/AtchafalayaBasinProject.pdf.

------. 1981. *Galveston's Bulwark Against the Sea*. Website accessed on November 2, 2012: http://www.swg.usace.army.mil/Portals/26/docs/PAO/GalvestonBulwarkAgainsttheSea.pdf

------.1997. *Wetland Engineering in Coastal Louisiana: Mississippi River Delta Splays*. Technical Note WG-RS-7.1. March.

------. 2001. *Riparian Terminology Confusion and Clarification*. Downloaded from the website: http://el.erdc.usace.army.mil/index.cfm.

------. 2003. *The Corps of Engineers and Shoreline Protection.* May 2003. Website accessed on November 6, 2012: http://www.nationalshorelinemanagement.us/docs/National_Shoreline_Study_IWR03-NSMS-1.pdf.

------. 2009. *Mississippi Coastal Improvements Program (MsCIP) Hancock, Harrison, and Jackson Counties, Mississippi. Comprehensive Plan and Integrated Programmatic Environmental Impact Statement.* USACE Mobile District.

------. 2012. *Bonnet Carre' Spillway*. February. Downloaded from the website: http://www.mvn.usace.army.mil/pao/bro/BC%20spillway%20booklet%20(two%20pages)%20.pdf.

United States Census Bureau. 1999. *Poverty in the United States.* Downloaded from the website: http://www.census.gov/prod/2000pubs/p60-210.pdf.

------. 2010. 2010 Census Data. Available at: http://www.census.gov/2010census/data/.

United States Department of Agriculture (USDA) National Agricultural Statistics Service (NASS). 2005. *Census of Aquaculture (2005): Volume 3 Special Studies Part 2, AC-02-SP-2. 2002 Census of Agriculture*. Downloaded from the website: http://www.agcensus.usda.gov/Publications/2002/Aquaculture/AQUACEN.pdf.

United States Department of the Interior (U.S. DOI). 2010. Notice to lessees and operators of federal oil, gas, and sulphur leases and pipeline right-of-way holders outer continental shelf, Gulf of Mexico OCS region; Biologically-sensitive underwater features and areas. NTL No. 2009-G39. January 27, 2010.

United States Energy Information Administration. 2006. The impact of tropical cyclones on Gulf of Mexico crude oil and natural gas production. Available at: http://www.eia.gov/forecasts/steo/special/pdf/2006_hurricanes.pdf.

United States Environmental Protection Agency (EPA). 1999. *The Ecological Condition of Estuaries in the Gulf of Mexico*. EPA 620-R-98-004. Office of Research and Development, National Health and Environmental Effects Research Laboratory, Gulf Ecology Division. Gulf Breeze, Florida.

------. 2011. *General Facts about the Gulf of Mexico*. Downloaded from the website: http://www.epa.gov/gmpo/about/facts.html.

------. 2013. Green Book. Website accessed on August 8, 2013: http://www.epa.gov/oaqps001/greenbk/astate.html.

United States Geological Survey (USGS). 2000. Coastal Prairie Factsheet. National Wetlands Research Center, Lafayette La.

United States Fish and Wildlife Service (USFWS). N.d.a. *St. Andrew Beach Mouse. 5-Year Review: Summary and Evaluation*. United States Fish and Wildlife Service, Southeast Region, Panama City Field Office, Panama City, Florida.

-------. 1993. *Recovery Plan for the Pallid Sturgeon.* Downloaded from the website: http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1034&context=endangeredspeciesbull.

-------. 1995. *Gulf Sturgeon Recovery/Management Plan*. Downloaded from the website: http://www.nmfs.noaa.gov/pr/pdfs/recovery/sturgeon_gulf.pdf.

------. 2001. *Florida Manatee Recovery Plan*, (*Trichechus manatus latirostris*), Third Revision. USFWS, Atlanta, Georgia. 144 pp. + appendices.

------. 2008. *Birds of Conservation Concern 2008*. United States Fish and Wildlife Service, Division of Migratory Bird Management, Arlington, Virginia. December.

-------. 2011. *National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.* Downloaded from the website: http://www.census.gov/prod/2012pubs/fhw11-nat.pdf.

------. 2012b. *Endangered Species Program*. Downloaded from the website: http://www.fws.gov/endangered/.

------. 2012c. Personal communication with Ben Frater of USFWS about Perdido Key Beach Mouse.

------. 2013. Breton National Wildlife Refuge. Downloaded from the website: http://www.fws.gov/breton/index.html

United States Forest Service (USFS). 2005. Rapid Assessment Reference Condition Model. Downloaded from the website: http://www.fs.fed.us/database/feis/pdfs/PNVGs/Southeast/R9WPSAgu.pdf.

United States Geological Survey (USGS). 2013. *Unconsolidated and semiconsolidated sand and gravel aquifers*. Website accessed on August 8, 2013: http://water.usgs.gov/ogw/aquiferbasics/uncon.html.

University of Texas. (2012). Shoreline Change Project. Website accessed on October 24, 2012: http://www.beg.utexas.edu/coastal/intro.php and http://www.beg.utexas.edu/coastal/download.php.

Weise, B.R. and White, W.A. 1980. *Padre Island National Seashore: A Guide to the Geology, Natural Environments, and History of a Texas Barrier Island*. Bureau of Economic Geology, University of Texas, Guidebook 17, 94 p.

Wilcox, B., D. Dean, J. Jacob, A. Sipocz. 2011. Evidence of surface connectivity for Texas gulf coast depressional wetlands. Wetlands 31:451-458.

Witherington B., S. Hirama, and R. Hardy. 2012. Young sea turtles of the pelagic sargassum-dominated drift community: habitat use, population density, and threats. *Marine Ecology Progress Series* 463:1-22.

Withers, Kim. 2002. *Shorebird Use of Coastal Wetland and Barrier Island Habitat in the Gulf of Mexico*. The Scientific World Journal, Volume 2. Research Article. February. Downloaded from the website: http://ccs.tamucc.edu/pubs/peer/withersgulfcoastshorebirds2002.pdf.